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THE INSTITUTE MEETING.

The recent meeting of the American Institute of Electrical Engineers emphasized the need of larger accommodations. A good number of members who attended were unable to find seats. On the other hand, the increase in membership is not as rapid as could be wished, but probably it is too soon to expect marked results of the efforts now being made for improvement in this regard. Not only should every electrical engineer consider it a privilege to join the Institute, but he owes it to his profession to assist in this way in its upbuilding and advancement.

The subjects assigned for the evening were timely and a number of interesting papers were presented, but too much time was taken in reading these and the discussions were meagre. If the papers are not discussed it is hardly necessary to go to the trouble of presenting them in this formal way. The chief reason for reading papers at a meeting is to afford opportunity for discussion. Although all seemed to agree in the opinion that the electric drive, which was the subject under discussion, is not only desirable, but necessary if the maximum output of the factory is to be realized, no one seemed anxious to compare the various systems now put forward for accomplishing this.

MISTREATMENT OF MEASURING INSTRUMENTS.

Electrical measuring instruments are in general, simple in construction, and if properly handled are not likely to get out of order. They are, however, delicately made. This is not an essential feature of the instruments as they could be made as sturdy as a railway motor. Such heavy construction as this type of design would involve is not desirable and, fortunately, it is unnecessary. The instrument maker designs his instrument so as to consume as little power as possible without sacrificing accuracy. The forces upon which he depends for operating his instrument are small and the moving parts must therefore be light and friction must be reduced to a minimum.

To attain this end, the maker uses very fine wire if the moving part is a coil. The spindle is carried in jeweled bearings and the pointer is made as light as possible and is held in its zero position either by means of a delicate spring or a small weight. The whole is enclosed in a light metal or glass case to protect it from injury and dust. Obviously with such construction as this the instrument must be handled with consideration. All shocks and jars are to be avoided and as much care taken in handling as would be awarded to a valuable watch.

Each instrument is adjusted before it leaves the factory and is carefully packed before shipment and it is fair to assume that in the great majority of cases it reaches its destination in good condition. From this time until it is finally mounted in its permanent position the treatment it receives varies with the experience and conscientiousness of the men who handle it. Frequently it is mounted on the switchboard at the factory and shipped while in this position to its final destination without any precautions being taken to prevent injury to the jewels due to jolting and shaking. A not unusual means of transportation is by a wagon over city streets and yet the installing engineer expects to find the instruments in perfect condition when the plant is started and when he does not he lays the blame on the instrument maker. When shipped in this way, the moving parts should be so packed that the jewel will suffer no injury.

It occasionally happens that when mounting the instruments the holes in the marble panel are not in exactly the right positions so that it becomes necessary to chip out at one or more points. The panel offers a convenient place to set the instrument while this is being done and the mechanic without a thought lays it there. There is nothing that will pierce the jewel of an instrument more easily than a jar while in this position and yet the workman will hammer away with mallet and chisel but a few inches off. Doubtless it is often the case that the mechanic who mounts the instruments knows very little about them so that those in authority should see to it that he receives proper instructions and obeys them.

Interchanging shunts and multipliers is a mistake easily made but it may prove disastrous to the meter. A case was recently reported in which an ammeter was condemned because it did not indicate when a load was thrown on the dynamo. The trouble was nothing more than reversed connections to the shunt, but it was not located until the maker had been called in. Evidently the men who mounted the instruments knew very little about them.

If the instruments are fortunate and pass through the process of fitting to the board and installation in the dynamo room, they are still not out of danger. The carpenters and plasterers seem to find them most convenient to support one end of their scaffolding. But it is rather hard on the meters.

In many plants, the instruments are

sadly neglected and are expected to go year after year without the need of cleaning or adjustment. A clock runs under much less trying conditions, yet less is expected of it.

PROGRESS IN MACHINE SHOP METHODS.

The progress which has been made in the last fifteen years in machine shop methods is undoubtedly largely due to the development of electrical apparatus. The demand for generators and motors of large size has made necessary radical changes in the methods of work and in the size of machine tools. In the early days of electrical engineering, dynamos were small and the lathes and tools then to be found in machine shops were amply large to build them. Electrical applications soon began to replace other methods of distributing power and light, and were found to have so many advantages over the older methods, and to be so applicable to entirely new work that their use increased rapidly. Entirely new fields were found, and the demands upon the generating station became so great that it was necessary to increase greatly the size of the generating sets. This, of course, called for very much heavier work in the machine shop, as well for building the engines as the generators. This increase in size has gone on steadily, until to-day we have engines of far greater output operating in stations than were ever thought of before, except for marine work.

When the machinist was confronted with the problem of handling these heavy masses, older systems of moving them from tool to tool upon rollers, or the use of small cars running on tracks laid throughout the shop, were found to be inadequate. Work could be carried on but slowly, and much space in the shop was wasted because of the necessity of leaving wide passageways throughout the entire shop. Then the overhead crane was introduced. This enabled the heaviest castings to be handled easily, quickly and cheaply. The use of cranes in shop work has probably done more to develop machine shop methods than any other single factor. As the size of the units increased, so did the size of the cranes, and here the electric system of operating cranes is so much superior to other methods that it practically stands alone to-day in this application.

Necessarily, as the work in the shop grew heavier, heavier tools had to be built; but a point was at last reached where it became easier to move the tool than to move the machine upon which it was to work. The shop engineer was again equal to the emergency, and practically converted the floor of the shop into a large bed-plate. When a new machine is to be constructed, the castings are brought into the shop by an electric crane and laid at some convenient point. Then the necessary tools for finishing are brought to the casting and set to work, and finally removed after their work has been completed. In this way a number of tools can be put in operation on one piece of a machine at the same time, and the work pushed without delay.

The construction of these enormous machines brought in new problems. One of these was the difficulty of accurately laying off angles and dimensions on such a large scale. Again the shop engineer was ready. He called to his aid the civil engineer, and by mounting a surveyor's transit on the floor of the shop, he lays off quickly and with precision his angles and dimensions. In practice, the transit is used to set a straight edge, which is then firmly clamped to the flooring. The portable tool is brought up and set against this, put to work, and the surface is machined and finished without trouble. The advantage of driving these portable tools by electric motors is obvious, as it is immaterial where or how they are placed. While planers are in operation, other tools, if it is thought desirable, can be put to work on other parts of the machine.

The electrical operation of machine factories, which is now so common, has not come in a day. Great opposition was met with and grave doubts were expressed as to whether the use of motor driving would justify the expense of installation. The electric drive has more than fulfilled the expectations of its first advocates. The saving of power effected by doing away with long lines of countershafts and belts is not a small item, but it is not in this that the great advantage of the electric motor lies. When a belt drive is used, the speed of the tool can be changed only by a change in gearing or by shifting the belt on a cone pulley. While there is not much trouble in doing this when the belt is small, there is trouble—and often danger—in shifting a large belt. It is troublesome for the machinist to change his gears in order to vary the speed of the tool, and unless he has a large amount of work to do at the new speed he is pretty sure not to make the change. With an electric drive the speed can be changed without trouble, and it can be easily set to give the maximum output of the tool. Here we have a positive drive, limited only by the capacity of the motor. Higher speeds and larger cuts can be taken than when the belt drive is used and slipping occurs. It is here that the electric motor shows the best results. If the output of the tool can be increased two or even three times, the motor doubles the value of the tool, and it would therefore justify an expense for installation almost, if not quite, as great as that incurred for the tool.

Moreover, by increasing the output of the tool, the expense for labor is greatly reduced, and in this way not only is the output of the shop increased, but the cost for work is decreased.

WATER-POWER DEVELOPMENTS IN SOUTH AFRICA.

It was recently reported that a large sum of money was to be expended in developing the water power of the Maguadzi River, in South Africa. The output of the plant will be fourteen hundred horse-power.

Africa is rich in large waterfalls. One of these, the Victoria Falls, on the Zambesi River, is the largest in the world, being even larger than Niagara. It is about a mile wide and four hundred and twenty feet high. Even in dry seasons the water is from two to three feet deep at the crest of the fall. It was reported last spring that a project was under way for developing this magnificent cascade.

Before many years, we may expect to see large centres of industry spring up within the neighborhood of these immense waterfalls. South Africa promises to take an important place among the manufacturing countries of the world.

The One Hundred and Seventieth Meeting of the American Institute of Electrical Engineers.

THE one hundred and seventieth meeting of the American Institute of Electrical Engineers was held on Friday evening, November 21, at 12 West Thirty-first street, New York city. The secretary announced the election of seventeen associate members. The president stated that the increased activity of the Institute under President Steinmetz's incentive had so increased the size of the Transactions that the board of directors had found it necessary to issue these in two volumes. The Transactions for the year 1901 include 900 pages. For the first six months of this year, which include the annual meeting, the increase had been thirty per cent over that of the entire previous year, and indications pointed to 1,600 pages as the probable size of the volume of Transactions for the current year.

The subject to be considered at this meeting—"Electric Variable Speed Control"—was introduced by President Scott. Applications of electric methods lead to development and to enlargement of former things, as well as to new work. Many things could be accomplished by these methods which were impossible before. Thus, the incandescent lamp had not only replaced old methods of illumination, but had created an entirely new field. The same was true of the application of electric motors, and particularly in regard to railway work and shop driving. The application of the motor has been followed generally by an increase in size, until the railway systems have developed from the slow-moving horse cars to the rapidly moving, heavy cars used to-day, which seems to have little in common with the systems from which they have developed.

The author thought that the use of electric cranes in factory work, for handling heavy material and tools, had done more to bring about progress in shop methods than any other single factor.

The introduction of electric motors into shops, for driving tools, makes many new things possible. The most striking of these is the variable speed control which can be obtained. The problem of securing a variable speed is purely mechanical, but no general mechanical means of solving this had been found, although for certain limited conditions mechanical methods had been satisfactory. The mechanical engineer had turned over the problem to the electrical engineer, who has solved it by the use of the electric motor so well that there is now practically no competing system. This work had not been done at once, but was the result of a careful study of conditions and many trials of this system. This method involved either an additional cost for installation or a loss of energy if wide variations were desired. However, the methods available were acceptable and even cheap, considering the increased output of the plant made possible by their adoption.

There are two types of direct-current motors—the series motor, having a variable speed, and the shunt motor which has, under normal conditions, a very constant speed. The speed of the latter, however, may be varied in a number of ways.

The induction motor is essentially a constant speed machine, having the same general characteristics as the shunt motor. Its speed may be varied by rheostatic control, by varying the number of poles of the motor or by varying the frequency of the supply.

The shunt motor for constant speed is simpler than for variable speed, and it may not always be desirable to adopt a variable speed. The elements to be considered in this problem are: What variation in speed is desirable? What speed changes can be secured by the use of belts? How delicate a change of speed is necessary? Group driving may be desirable in some cases, and it may also be desirable to avoid the complexity involved in introducing variable speed control. And, finally, what are the advantages of variable speed which will dictate the selection of a system for the entire shop?

The papers that were presented were the results obtained from actual trials, and were not merely theoretical solutions. Mr. Scott closed his remarks by cautioning the electrical engineer against going too far in the adoption of a variable speed drive. The whole problem should be considered and that system most suitable for each shop should be selected.

The first paper of the evening was on "A Series Parallel System of Speed Control," by Mr. George W. Fowler. In the absence of the author, this was read by Mr. D. A. Burnett. This described the C. & C. series parallel system, which has been successfully used for driving various kinds of machinery, especially printing-presses. The component parts of the system are a double commutator type motor, a switchboard, a controller, a pair of automatic solenoid switches and a set of emergency switches. The motor is of the ordinary slow-speed compound-wound type, with the exception that it has two separate windings having no connection, and commutators on the one armature body operating in one magnetic field. The field windings are so arranged that the series turns can be cut out after starting. The contacts on the controller are divided into two separate sections, one set being subdivided into many small contacts, and the other into larger contacts. This system of smaller contacts is used when the armature windings are placed in series, the other only when the windings are in parallel. In any variable speed control system, wherein a combination of windings on the machines is used to obtain the speed variation, it becomes necessary at some point in the operation to open the circuit. In this system this is accomplished by the use of an automatic solenoid switch, which changes the armature windings from series to parallel, and *vice versa,* without excessive flashing and without magnetic blowout coils. Two of these automatic switches are used—one to perform the operation of changing over from series to parallel, and the other for starting and stopping the motor. In some cases it is necessary to be able to stop the motor from any one of several points, and this can be done in this system. The operation of the system is then described in detail. In starting up, the current flows through the two armature windings in series, in series with the series field and in series with the resistance. This gives the lowest speed obtainable, which may be five per cent of the maximum. The series resistance is then gradually cut out, next the series field is cut out, leaving the motor running as a shunt machine. The next step changes the armature windings from series to parallel, inserting at the same time enough resistance to prevent a sudden change of speed, the final steps being a gradual cutting out of the resistance in the armature circuit. A still further increase in speed is obtained by varying the shunt field. The motor is stopped by opening the starting switch, after which it can be started only by going through the steps just outlined. The system is then compared with the

rheostatic control and its marked advantages pointed out. Less current is required and the efficiency is better at all speeds for the former.

The second paper of the evening was by Mr. H. B. Coho, and was entitled "The Storage Battery as a Factor in Speed Control." The advantages of the storage battery as an auxiliary or independent source of supply for obtaining a variable speed, particularly in connection with the operation of printing-presses, were pointed out. For printing-press work a wide range of speed becomes necessary, and there are a number of methods which may be used to obtain this. When a storage battery is used, the speed of the motor is varied by varying the applied voltage, leads being run from various points in the battery. As this battery will be in use but a short time, it can be comparatively small, and its cost will not be excessive. One battery will do for a number of presses and can be charged at a very low rate, thus ensuring the best possible results from the battery at a minimum cost of current. It has no moving parts and its electromotive force is constant. The use of a battery for the multiple voltage operation of machine tools presents another phase of the subject. Here the high cost militates against their adoption, but this will be somewhat offset by the increased efficiency of the system. As a substitute for storage batteries, the so-called counter-electromotive force cells can often be used. These are constructed with unformed lead electrodes, the necessary electrode surface being determined by the internal resistance requirements for economic operation. The cutting down of supply voltage by counter-electromotive force is a natural method dictated by economic considerations, while to cut it down by resistance is unnatural. It is probable that the latter method of multivoltage control, taken in connection with the weakening of the field to give at least twenty-five per cent speed variation, will result in the most economical system to install, with the lowest first cost for installation.

The third paper of the evening, entitled "Electrically Operated Coal Hoist for Variable Speed Control," by Mr. P. O. Keilholtz, stated that there were two different operations in coal hoisting —raising the loaded shovel, and lowering it empty. All that is required for raising is a smooth acceleration for closing and raising the shovel, and full power application as long as possible in order to decrease the time of hoisting. Full power application can be continued longer with the electric hoist than with steam. A smooth acceleration is required to prevent objectionable strains in the structure or damage to the gearing. In lowering the empty shovel, the electric hoist has marked advantages, doing away with mechanical braking and the difficulty of dissipating the large quantity of heat thus generated. Further, the mechanical brake does not act as smoothly and as certainly as does the electric brake. The Ward Leonard system of control is used. The actual results obtained in a hoist of this type are given. From these it is seen that it took eleven seconds to close the shovel and fifteen seconds to raise it, loaded, 126 feet. The power taken is given, and the efficiency is shown to be fifty-eight and one-half per cent. The rate of lifting is seventy tons an hour. The equipment consisted of a main motor of 150 horse-power, driving an 85-kilowatt generator. The hoisting motor is rated at 100 horse-power.

The fourth paper, entitled "Motors for Machine Tools," was presented by Mr. F. O. Blackwell. He described the different classes of work required of machine tools and the various methods which can be used to obtain variable speed. The main question to be considered in the adoption of the variable speed drive was how far could this method be used. The same horse-power is required to remove metal, independent of speed. Therefore, at low speed, secured by low voltage, a greater armature current is necessary. By the use of the three-wire system and the variable field, a change of speed from four to one can be obtained. By the use of gears, this can be made sixteen to one, or more. The use of the magnetic brake for throwing in the gears is touched upon. When a cone pulley was used with belts for variable speed, the full output of the tool can not be secured, and, moreover, the system is not flexible. The electric drive gives a greater output of the tool. The author then pointed out that on a three-wire system a motor twice as large as that found necessary for a two-wire system should be used, while for a four-wire system the motor should be four times as large. The three-wire system is generally available, and does not require two generators. The four-wire system requires two machines, one of these having two commutators, and involves an increased cost. He thought that the three-wire system was the best, using a field control of two to one, giving a total range in speed from four to one. He then showed diagrams illustrating the greater output procurable when electric driving is adopted, as the speed can always be kept as great as the tool will stand. In the case cited, the time taken to remove a certain amount of metal was reduced from sixty minutes with the belt drive to thirty-two minutes with the electric drive.

The fifth paper was entitled "Multiple Unit Voltage Speed Control for Trunk-Line Service." This was by Mr. H. Ward Leonard. The author recalled his historic paper presented to the Institute in 1894, and expressed his pleasure that today so many engineers had declared themselves in agreement with the essential features then enunciated. He then described his system as applied to two locomotive units for trunk-line service. A single-phase alternating current of high potential is used for transmission. This is collected by a suitable contact. If desired, it may be transformed down by transformers placed at intervals along the line; or the transformer may be carried upon the locomotive. Upon the latter, a single-phase synchronous motor drives a direct-current generator and a small exciter. The traction motors are coupled directly to the generator, and a rheostat is introduced into the field of the latter. The fields of the motors are excited by the exciter. Four wires are carried along the train, which enable all the motors and generators on the train to be excited from the one exciter. By operating the controller, one of which is placed on each locomotive, the potential applied to all of the traction motors may be varied simultaneously. In this way, the required tractive effort can be obtained at any voltage from the lowest to full speed voltage in either direction. The inventor claims this system has the following advantageous features: The haulage over existing road-beds of very much heavier trains than can be hauled by steam; a reduction in the cost of maintenance of the locomotives and in the maintenance of the road-bed; a material increase in the weight of the train which can be hauled around a certain curve by a locomotive having a certain weight on drivers; an increase in the load which can be started; a reduction of the dead load, and an increase in the number of trains; any number of locomotives can be operated from one point; fifty per cent of the energy now wasted in braking can be restored to the system; the first cost of equipment will be less than with any other system for similar service which involves the use of substations; the cost of haulage per ton-mile will be reduced; difficulties due

to electrolysis are reduced to a minimum.

The sixth paper of the evening was presented by Mr. N. W. Storer, and was entitled "Three-Wire System for Variable Speed Motor Work." In deciding the method of applying power to machine tools, the choice lies between a separate motor for each machine and group driving. Variable speed work may be divided into three classes — Machines requiring a torque increasing with the speed; machines requiring a constant torque, and machines requiring approximately the same maximum output at any speed or a torque varying inversely as the speed. This class includes most machine tool work where automatically constant speed regulation is especially desirable. The author then describes a system as developed by the Westinghouse Electric and Manufacturing Company. This is a three-wire system, the neutral being run to the centre of two autotransformers which connect the three slip rings to the armature of the direct-current generator. This machine is practically a two-phase synchronous converter. A standard type motor is used on this system. If only a small variation in speed is desired, this is secured by changing the shunt field current, and a third wire is not necessary. The use of the three-wire system enables a variation of speed from six to one to be obtained. Greater variations may be obtained if desired, but are not to be recommended except in special cases, as the size and cost of the motor would be greatly increased. The size of the motor is determined by the output at the lowest speed. These motors commutate very successfully at all voltages. The speed regulation is good, and changes may be made smoothly from one speed to the next. The efficiency of the system is high. When operating on a low voltage, the motor is at all times running under full-load conditions. When operating at a high voltage, the efficiency corresponds to the half-load efficiency of a standard motor. The efficiency of transmission is high, as is also that of the generating plant. The advantages claimed for the system are summed up as follows: Simplicity, not only in the generating plant, but in the transmission line, motors and controllers; economy in first cost of generating plant for transmission lines; constant speed regulation from no load to full load; smoothness of operation in changing from one speed to another.

The last paper of the evening was read by Mr. R. T. E. Lozier, being entitled "The Operation of Machine Shops by Individual Electric Motors." From data that have been collected on power transmission in industrial shops, it appears that if a certain maximum horse-power is required for all the tools of the shop—say, 100 horse-power—it will require at least 100 horse-power additional to transmit this effectively by belts and shafting. This loss remains constant whether the effective horse-power is reduced or not. If the same tools be driven by individual motors, only forty-three horse-power is required for transmission, even if every tool is running. However, it has been determined that in the ordinary manufacturing establishment the mean effective power is but thirty per cent of the total. Applying this load-factor, it is found that there is but thirty mean horse-power to use, and that the use of belts requires 100 horse-power to transmit this, giving a real efficiency of about twenty-three per cent. With the individual drive there is generated thirty-nine horse-power, of which thirty is effective, giving an efficiency of seventy-seven per cent. Assuming that steam power costs $36 per horse-power per year, with the shaft and belt system the power would amount to about two per cent of the cost of the establishment's product. With subdivided motors it would be one per cent, and with individually driven motors it would be something less than 0.4 per cent. Assume that in a very large machine shop sixty per cent of the motors installed is to have a variable speed. Of the sum of the aggregate rated capacity of a variable speed motor and that of a constant-speed motor, thirty-five per cent fairly represents the mean power that all of these motors will be required to furnish if they are all running at the same time. It is found that the average power that must be provided by the generating plant is but ten and one-half per cent of the aggregate rated capacity of the individual motors installed. It can not be assumed that this ten and one-half per cent is the capacity of the generating plant, because a provision must be made for the maximum condition. However, the system is so efficient that ample margins of, say, 100 or 200 per cent can be applied. The author then discussed the various methods of securing a variable speed control. About seven years ago Mr. Thomas A. Edison put into operation a principal that had long been accepted by him, that machinery and equipments were cheaper than labor and general expenses, and that it was better to use up your machinery at a high rate if by so doing you materially increased your output. About four years ago the matter of determining exactly the speed limitations of iron-working machinery was taken up by a few engineers, and these limits have since been kept in view with the greatest success. The operator has been led to recognize the benefits to be obtained by an increased output, by securing to him his mean wage and allowing him to share in the benefit gained by working to his normal capacity. In the last system, the operator is given explicit directions as to the shape of the cutting tool, the feeds, speeds and general methods to be employed in doing the work, and the exact time involved in such methods. This card states conditions that can be easily obtained in practice. If the operator succeeds in meeting these conditions, he receives a fixed bonus in addition to his regular pay. With such a method of operation, tools must be supplied that will stand up to the work. There must be a range of speeds from which to select, and the machine tool must have sufficient strength to stand the strain that may be put upon it. The limit of high-speed operation is not to be found in cutting tools or in the ability of motors, which successfully do the work under variable speed, nor to first cost, but has been found in the stability of the machine tool itself.

The discussion of these papers was opened by Mr. G. S. Dunn. He regretted that as his company was at the present time engaged in litigation over a system of variable speed control he would have to refrain from entering into the discussion. He, however, called attention to the fact that the capacity of motors is in many cases limited by the conditions of commutation. If the field of a motor were reduced to one-half, it would be impossible, without special design, to commutate successfully under full load. From these considerations, he thought that a special design of motor would be required and that this would increase the cost of installation.

Mr. Horace Dowie pointed out that there were really two problems presented —that of the maximum range of speed, and that of the partial range of speed. To endeavor to cover the whole range with one machine demanded an excessive weight. Double-commutator machines would, however, reduce this, as would also the use of boosters or retarders. For wide changes of speed, gears could be used.

Mr. H. N. Heath stated that while wide

ranges of speed, produced by varying the field, called for large motors, they could be made so that they would commutate sparklessly, and the cost would not be excessive.

Mr. S. T. Dodd thought that the Ward Leonard system would involve a great increase in the weight of the locomotives, due to the addition of the motor-generator sets.

Mr. Arthur Williams thought that Mr. Lozier's averages were too small for the demand, and that the power-factor of the system would be nearer thirty per cent. With three-wire systems there was a chance of unbalanced loads. The cost of installing individual motors, although greater, would be somewhat offset by the savings in shafts and belting. The higher speed and economy make the individual drive desirable. Belt losses of fifty per cent, or greater, with power at sixty to seventy cents per kilowatt-hour, will cost about $30 per horse-power per year.

Mr. Philip Lange stated that his company varied the speed by using several frequencies. For intermittent stops a mechanical device was used.

Mr. Charles Day thought that the main question, "does it pay to use individual drives?" had not been answered, and he asked the question, "does it pay to use a variable speed?" In the consideration of this question, it is necessary to go back to the quality of the material used. He did not think that slight variations in speed were necessary, that the great advantage of this method of operation lay in the fact that the operator when changing his work could instantly adjust the speed so as to secure the maximum result. Here the electric motor was most advantageous. For successful operation, machines must be run at the maximum rate. This can not be done when belts are used, but is easily accomplished by motors. No one example can prove a saving, as this can only be decided by the ultimate output of the plant. The advantages of the individual drive have not been fully appreciated, and he again emphasized the fact that the tools must be operated up to limit, and that the saving secured in this way justified any outlay for machinery.

In reply to the points brought out in the discussion, Mr. Lozier stated that they did not find that motors bunched up on any one voltage, and that it was now up to the tool builder to make tools strong enough for the new conditions.

Mr. Storer stated that there was no difficulty in making motors which would commutate with a half field, that these motors are now a standard make. For multivoltage systems, however, special motors will be required.

Mr. Leonard called attention to the fact that his system required no special machines. The best steam locomotive of to-day had but fifty per cent of its weight on the drivers, and the tractive effort was limited by the skidding of the wheels. The whole problem in locomotive design had narrowed down to increasing the weight on the locomotive drivers, so that the additional weight in his system did not seem to be a disadvantage. Moreover, the weights of the machines installed on his locomotives could not be compared with the ordinary steam-driving units, but only with turbine-driven generators. The problem to-day in handling freight is that of increasing the weight of the trains, and he did not think that an increase of fifty tons on the locomotive, even should this be required by his system, would be a matter of any importance.

Mr. Coho stated that he has a motor which operates with a field variation of 300 per cent.

THE STORAGE BATTERY AS A FACTOR IN SPEED CONTROL.

BY H. B. COHO.

In presenting this paper to the Institute, nothing very new or novel in the idea of varying the voltage across a battery, in order to secure speed variation, is claimed. There seem to be some differences of opinion as to the rights of different persons to the multiple voltage system of control, and this opportunity is taken to call attention to the part which the storage battery may play in this important work. The many shortcomings of the storage battery are appreciated, but recent experience has taught that while the watts per pound of material have not been so materially increased in recent years, the life of high-grade storage cells has been increased to such an extent that the old ideas as to cost of maintenance will have to be modified, and the charges of ten per cent and fifteen per cent of first cost per annum for renewals must be cut in half.

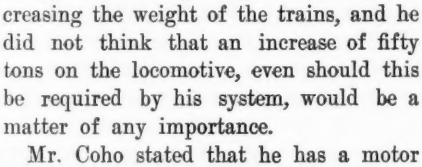


FIG. 1.—CONNECTION TO STORAGE BATTERY METER.

All are no doubt quite familiar with the various ways in which batteries may be utilized, and it is the purpose in this paper to dwell particularly on a method of using a storage battery, as an auxiliary or independent source of supply, in connection with the operation of printing-presses.

With printing-press work, the operation of making up and threading in paper requires a positive fixed speed of from twelve to twenty revolutions per minute on the main shaft of the press. The methods of obtaining this speed from electric motors, which are common, are to employ either fixed resistances, armatures in multiple and series, or separate sources of supply, such as motor-generators. The motor in the last case is a shunt machine, wound for the line voltage, while the generator is a shunt machine with field separately excited from the line and supplied with a constant voltage. The armature is wound to give a fixed voltage from twelve to forty volts, depending upon the special requirements.

It is in connection with this last system that the method mentioned in this paper is particularly applicable. Fig. 1 shows the connections to the storage battery and to the motor through the controller. The following data have been obtained in connection with the utilization of this system for the operation of quadruple Hoe printing-presses of moderate size. These presses operate at twelve revolutions per minute in making up and threading in, and require for this purpose a current of 150 amperes and 40 volts. The threading in and making up process per press lasts at a maximum not more than ten minutes. This process has to be repeated not more than fifteen times in twenty-four hours. From these data it is apparent that a 200-ampere-hour battery on an hour rating will more than fulfill the requirements.

A battery of accumulators to give forty volts and 200 amperes for one hour will cost not more than $400, which is not a prohibitive figure, especially when considered in connection with the following additional advantages:

a. One battery will do for a number of presses, for the reason that all of the presses in any establishment are not simultaneously in operation.

b. The battery can be on charge at a very low rate at all times when current is

flowing on the mains, thus ensuring the best possible results from the battery at a minimum cost for current.

c. The battery having no moving parts, such as bearings and commutators to get out of order, will doubtless appeal to the press operators.

d. The electromotive force of a battery is constant, while that of any other independent source of supply is variable, depending upon the line voltage. Many a press operator has lost his fingers because of sudden variations of voltage supplied to the motor.

The operation of elevator motors by means of a storage battery placed directly across the line, and in connection with a multiple series controller, offers an excellent means of varying speed. The battery can be figured on a two-hour rate in the severest service, so that the first cost is not excessive, while the saving from repairs to resistance plates and contact pieces is a matter of no small importance in comparing the economic advantages of two systems.

The use of a battery for the multiple voltage operation of machine tools, presents another phase of the subject. The high first cost of batteries militates against their adoption. In a shop requiring about 100-kilowatt average motor load, the battery capacity will have to be calculated on a three-hour rating. The first cost will be about thirty per cent more than that of equivalent multiple voltage generators as now employed. That the battery is thirty per cent more expensive in first cost does not, however, exclude it from competitive consideration, because of the increased efficiency of the cells over that of multiple voltage generators when operating at varying loads.

As a substitute for storage batteries one can often use so-called counter-electromotive-force cells. These may be constructed with unformed lead electrodes in an ordinary battery electrolyte. The necessary electrode surface is not determined by the ampere-hour capacity of the plates, but by the internal resistance requirements for economic operation. The cost of construction of these cells is much less than that of equivalent batteries. The cutting down of supply voltage by counter-electromotive force is the natural method dictated by economic consideration, while to cut it down by resistance is unnatural.

Referring to the above paragraph, it is probable that careful examination will prove that the latter method of multiple voltage control, taken in connection with the weakening of the field to give the last twenty-five per cent speed variation, will result in the most economical system to install and the lowest first cost for operation.

A SERIES-PARALLEL SYSTEM OF SPEED CONTROL.

BY GEORGE W. FOWLER.

The system of control of stationary direct-current motors which I shall endeavor to describe to you is commercially known as the "C. & C. Series-Parallel" system. For some three years the system has been quite extensively and successfully used for driving various kinds of machinery, especially large printing-presses.

The component parts of the system are a double commutator type motor, a switchboard, controller, a pair of automatic solenoid switches, and a set of emergency switches.

The motor is of the ordinary slow-speed, compound-wound type, with the exception that it has two separate windings and commutators on the one armature body, operating in one magnetic field. The field windings are so arranged that the series turns can be cut out after starting, thus obtaining the advantages derived by using a compound-wound motor at starting, exerting a powerful starting torque with a minimum amount of current; and the constant speed features of the shunt motor, by cutting out the series after the motor has reached a certain fixed speed.

The armature windings are, of course, thoroughly insulated from each other, and have no connection excepting that obtained through the operation of the controller.

By an inspection of the controller, it will be seen that it consists of numerous contacts and contact rings mounted upon a slate, the substructure carrying the controller arm, which moves over the contacts. For convenience, some external means is generally used to operate the controller, such as the lever, which is frequently used in connection with printing-press work. It is through the movement of this one controlling lever that all the combinations of windings and connections, with the resultant variations in speed, are obtained.

Upon closely examining the controller, it will be noticed that the contacts appear to be divided in two separate divisions. To the left the contacts are subdivided into many small ones. To the right there are but few larger ones. Those to the left are in use only when the armature windings are in series, while those to the right are in use only when the windings are in parallel. The two divisions have no connection with each other whatever. For use in graduating the speed, there are two banks of resistance used; one bank in circuit with the armature windings when they are in series, and which is connected to the smaller contacts to the left, and another bank in circuit when the armatures are in parallel, and which is connected to the larger contacts, to the right. The contact rings on the controller are in circuit with the shunt field of the motor, and the small round contacts for the purpose of interposing resistance therein for the highest speeds.

With any variable speed control system wherein a combination of windings or machines is used to obtain the speed variations, it generally becomes necessary at some point in the operation to open the circuit, preparatory to making some rapid change in the combination, in order that the speed changes shall be gradual. When performing this operation it has been, and now is, the custom to use magnetic blow-out coils to prevent excessive flashing of the controller contacts. In the series-parallel system it is necessary to open the circuit when changing from series to parallel, for it is quite obvious that the windings can not be in series and parallel at the same instant.

In this system of series-parallel control no blow-out coils of any kind are used and the change from series to parallel, or *vice versa*, is obtained by the use of an "automatic solenoid switch."

Two solenoids enclosed in a cast-iron case, the object of which is to form a good path for the lines of force, are mounted upon one side of a slate. Through the centre of these solenoids is a plunger slotted in the centre through which passes a small pin, thereby making a flexible connection between it and the shaft carrying the switch arm on the opposite side of the slate. When energized at the proper time, first one and then the other solenoid operates, throwing the switch arm to the right or left, as the case may be. The connections of the switch jaws shown on the front of slate are such that when connection through them is completed by the switch arm, the armature windings on the motor are first in series, and when the arm goes to the other side the windings are in parallel. Therefore, during the time when the switch is operating from series to parallel, the circuit is opened; the action being instantaneous, there is no noticeable change in the speed, neither is there the slightest flashing at the contacts of either controller or switches.

Two of these automatic switches are

used with each equipment, one to perform the operation as outlined above, the other to "stop and start" the motor—that is, to open and close the circuit. There is no open point on the controller except between the series and parallel side, and when the lever is thrown to the position which is normally "off," the solenoid switch used for this purpose opens the circuit. Likewise, when the lever is moved "on," the switch closes the circuit. This absolutely prevents the slightest flashing at the controller contacts when stopping the motor. By the use of the second mentioned switch, it is also possible to stop the motor from any one of several points, which is required in newspaper printing.

To accomplish this an emergency switch is used. This switch is so connected with the controller (see Fig. 2) that when the plunger is depressed, connection is made through the solenoid, which throws the switch "off."

In Fig. 2 is represented a diagram of the wiring and connection of a complete series-parallel equipment. A careful inspection will disclose the following conditions when the equipment is in operation.

With the controller lever "off," the two solenoid switches are in a position corresponding to "off" on the one and "series" on the other. The lever being moved to contact 2 (on controller) one solenoid switch throws "on," the other still remaining in a series position. The current then flows through the two armature windings, in series, in series with the series field and in series with the resistance connected between controller contacts 1 to 40. This gives the slowest speed obtainable, which, when used for newspaper printing, is five per cent of the maximum. The next successive moves of the controller lever simply cut out resistance in the armature circuit, until contact 38 is reached, when it is all out. At this point the series field on motor is gradually cut out. As will be noticed, the series field is connected to terminals 7, 8 and 9 on the controller, and permanently attached to terminal 7 is a small quadrant switch operating between two switch jaws, on 8 and 9. As the controller lever moves under 7, 8 and 9, the switch at 7 is engaged by the controller and enters switch jaw on 8. This short-circuits one-half the series field coils on motor. Continuing the movement of controller, the switch enters switch jaw at 9, thus connecting 7, 8 and 9 and entirely cutting out the series field. Therefore, the motor is now running as a shunt machine, with the armature windings in series.

Now, as the controller lever is moved to cover contact 41 and 42, the solenoid switch previously mentioned is brought into connection and changes the armature winding from series to parallel. At the same time enough resistance is inserted in the circuit to keep the speed and current normal. (See curves, Fig. 3.) As the lever is moved over 43 and 44, etc., resistance is gradually cut out until 49 is reached, when the motor is running without resistance in the armature circuit and the windings in parallel. There are still five more speeds, which are obtained by inserting resistance in the shunt field. At the last of these the speed of the motor is at its maximum. To stop, the emergency switch connected as shown on Fig. 2 may be operated, which throws the solenoid switch "off," thereby opening the circuit, and stopping the motor.

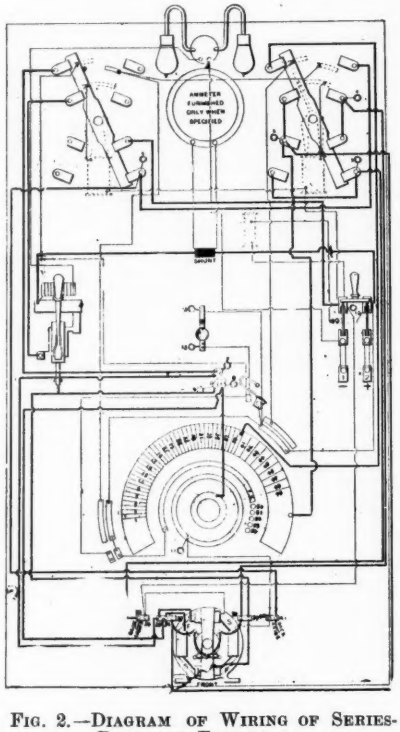


FIG. 2.—DIAGRAM OF WIRING OF SERIES-PARALLEL EQUIPMENT.

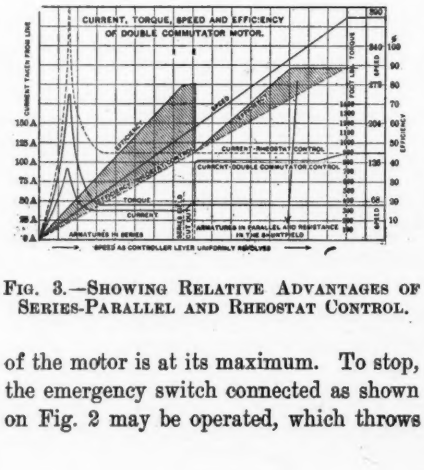


FIG. 3.—SHOWING RELATIVE ADVANTAGES OF SERIES-PARALLEL AND RHEOSTAT CONTROL.

Before the above operation can again be repeated, the lever must be brought back to the starting point, when over contact 2, one switch is thrown back to "series" (that is so that it connects the armature windings in series) and the other switch "on." Then to continue as before would simply be to move lever from 2 and so on, or if to stop it altogether, move to contact 1, where the solenoid switch throws "off."

The diagram of connections shows a slightly different type of solenoid switch from that illustrated; one in which a single solenoid accomplishes the same result. This is shown thus, as it is much easier to trace out the path of current, in illustrating the operation of the system.

The relative advantages of the series-parallel system over the rheostat control with one commutator is readily apparent by an inspection of Fig. 3, in which the curve shows the comparison between the two systems, when operating a Hoe quadruple press. It will be seen that the current required to exert the maximum torque when starting the press from rest is somewhat less than the current required for the same operation by a single compound-wound motor with rheostat control. Also the efficiency at all speeds is much better.

While the system was originally designed especially for operating Webb presses, it is equally well adapted to any service requiring heavy starting torque, a wide range of speed variation, ease of manipulation and high efficiency.

ELECTRICALLY OPERATED COAL HOIST, HAVING VARIABLE SPEED CONTROL.

BY P. O. KEILHOLTZ.

The use of electric machinery for coal hoisting has many advantages over steam machinery when the hoist is considerable. It has also the advantage of less cost of operation and maintenance. Its initial cost, however, is greater.

There are two distinct operations in coal hoisting: Raising the loaded shovel and lowering it empty. All that is required for raising is a smooth acceleration for closing and raising the shovel, and full power application as long as possible in order to decrease the time of hoisting. Full power application can be continued longer with an electric hoist than with steam, owing to the less inertia of the former. A smooth acceleration is required because the cables are without stretch and for very high hoists would

introduce objectionable strains in the structure or damage to the gearing. It is in lowering the empty shovel that the electric hoist has marked advantages. With steam hoist the lowering is accomplished by braking, and with high hoists,

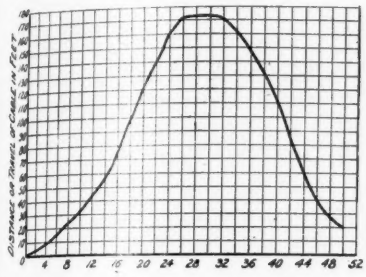


FIG. 4.—TIME IN SECONDS.

large shovels and rapid lowering the large amount of heat generated by the brakes is difficult to get rid of. As brakes depend upon friction, which is a function of two things—the surface conditions and the pressure between the rubbing surfaces—the amount of friction is uncertain, and braking, therefore, is objectionable because violent surgings are introduced in the boom structure and power. With the electric hoist, owing to the perfect reversibility of the electric motor, the motor is used as a generator having a separately excited field and driven by the weight of the descending bucket. In its armature circuit is a rheostat to dissipate the heat generated. It is at once apparent that this heat dissipation can be better accomplished with a rheostat than with a brake band.

The Ward Leonard system of control is used and the apparatus consists of a motor-generator set and a hoist motor which receives its power from the motor-generator set, the motor of which is supplied with 550-volt direct current. The field of the generator is separately excited and its strength is controlled by the operator by means of a foot-operated rheostat. The field of the hoist motor is excited by the 550-volt direct current. By means of a double-throw, three-blade switch the foot rheostat is cut out of the generator field circuit and cut into the field circuit of the hoist motor, and the armature leads of the hoist motor cut from the armature circuit of the generator to the rheostat.

Appended will be found sketches of distance-time curve and a velocity curve, together with data of test and other particulars.

Weight of coal hoisted, average of seven shovelfuls.....lbs.,	2,337
Weight of shovel empty..... "	2,900
Total weight, lifted exclusive of weight of ropes..... "	5,237
Average lift.....feet,	126
Readings of main motor:	
Volts.....	540
Average current in amperes to close shovel.....	57
Maximum current in amperes to close shovel.....	73
Average current in amperes to raise loaded shovel.....	189
Maximum current in amperes to raise loaded shovel.....	243

Field current, not included in above, 2.8 amperes.

From the velocity curve (ascending) it will be seen that it took eleven seconds to close the shovel, and from the distance-time curve twenty-six seconds to close the shovel and raise it to the dumping hopper. Therefore, fifteen seconds is the time taken to raise the loaded shovel; and as the lift is 126 feet, the average velocity is 8.4 feet per second.

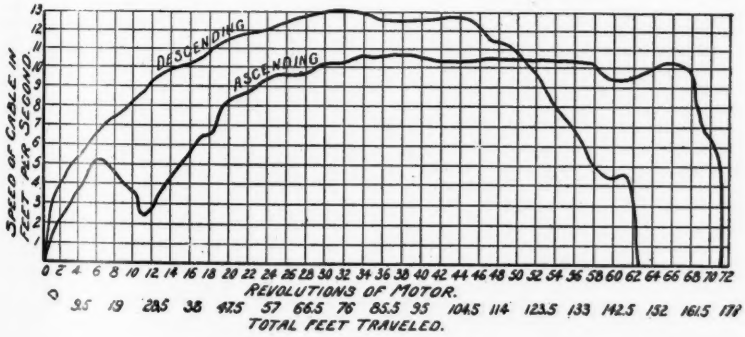


FIG. 5.—VELOCITY CURVE.

The efficiency is,

$$\frac{\frac{8.4 \times 5{,}237}{550}}{\frac{189 \times 540}{746}} = 58\tfrac{1}{2}\%$$

Performance Test—Coal lifted, tons, 101.86; time, minutes, 87.33; rate, 70 tons per hour.

PARTICULARS OF ELECTRICAL APPARATUS.

Main Motor—M. P., 6/150, horsepower, 450; volts, 550.

Generator—M. P., 6/85, kilowatts, 450; volts, 250.

Hoist Motor—M. P., 6/100, horsepower, 200; volts, 250.

MULTIPLE UNIT, VOLTAGE SPEED CONTROL FOR TRUNK LINE SERVICE.

BY H. WARD LEONARD.

In February, 1894, I read a paper before this Institute describing a system which I considered applicable to the operation of a trunk line electric railway. The essential features of this system were:

First—The generation and transmission of a high-tension, single-phase alternating current, the power-houses being placed as far apart as the insulation of an alternating-current transmission would permit.

Second—The entire elimination of substations.

Third—A transformation of the energy upon the locomotive so as to secure a voltage speed control for the electric motors, thereby obtaining smooth acceleration and efficient control of the locomotive at any desired speed and in either direction.

At that time there were no engineers, so far as I know, who agreed with me that these features were essential for the operation of a trunk line railway by electric motors.

In the recent past, however, many prominent engineers, both abroad and in this country, have declared themselves in favor of these essential features, and I therefore feel warranted in describing an improvement upon the system I originally proposed, by which I can secure the important and now well-understood advantages of a multiple control of any desired number of locomotive units.

Fig. 6 illustrates diagrammatically one form of my multiple unit voltage speed control as applied to two locomotive units for trunk line service.

The current is generated in the form of a single-phase alternating current at as high an electromotive force as is practicable to-day, say, 20,000 volts. A moving contact leads the single-phase alternating current upon the locomotive. If desired, static transformers can be placed at suitable points along the line of the railway which will reduce the initial electromotive force to any desired lower electromotive force upon the contact conductor.

In many instances it may be desirable to place upon the locomotive a transformer S′ for reducing the tension of the alternating current led to the synchronous motor A^1.

A single-phase synchronous motor on the locomotive receives this alternating current and is driven by it continuously

at a practically constant speed, the current after passing through the motor being led to ground through a moving contact. This single-phase motor A^1 drives continually a small exciter E^1 and also a large continuous-current dynamo D^1 whose field is separately excited by the exciter E^1 and has its field circuit a reversing field rheostat R^1. The armatures of the propelling motors are connected in multiple directly across the terminals of the armature of the dynamo D^1. The field magnets of the propelling motors M^1 are separately and constantly excited by the exciter E^1.

By manipulating the reversing field rheostat R^1, the current through the armatures of the motors M^1 necessary to obtain the required tractive effort can be obtained at any desired voltage from the lowest voltage to the full-speed voltage, and in either direction.

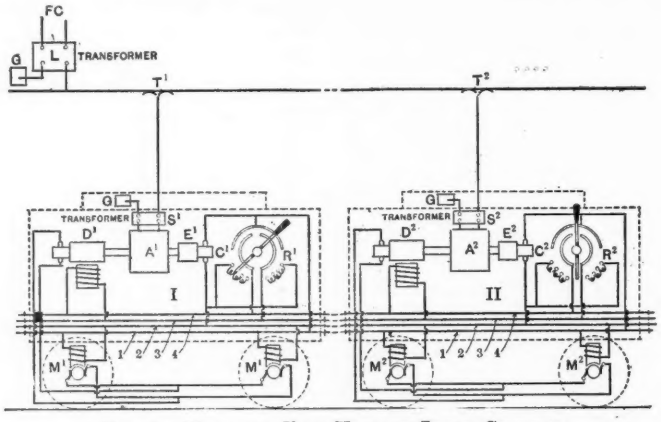


FIG. 6.—MULTIPLE UNIT VOLTAGE-SPEED CONTROL.

A perfectly smooth and rapid acceleration can thus be obtained with minimum energy from the source of supply.

The simultaneous multiple control of the several locomotive units is obtained by means of the four small wires 1, 2, 3, 4, which are led along the train.

In Fig. 6 the operator is supposed to be upon the locomotive I. The exciter E^1, which is producing a constant electromotive force, has its terminals connected to the wires 1 and 2. Across these wires 1 and 2 are connected the field windings of all of the propelling motors on the two locomotives, so that they are all constantly and fully excited.

The wires 3 and 4 are also supplied by a current from the exciter E^1, but the reversing field rheostat R^1 is in the path of this current. The fields of the two dynamos D^1 and D^2 are connected in multiple across these wires, 3 and 4, which extend along the train.

It will be evident that by manipulating the reversing field rheostat R the operator can vary simultaneously and similarly the field exciting currents supplied to D^1 and D^2, and that therefore he can cause the voltage of these two dynamos to vary in exact unison from 0 to the maximum voltage in either sense. Thus the operator can cause the two locomotives to start, accelerate, run at full speed, retard and reverse in perfect unison, always dividing the load perfectly under these various conditions.

By placing the controller R^1 in its open position and going to the other locomotives, the operator can similarly control the two locomotives simultaneously by means of the controller R^2.

By the use of this system I expect to be able to secure the following advantageous features:

First—The haulage over existing road-beds, grades, bridges, etc., of very much heavier trains than can be hauled by any steam locomotive.

Second—A material reduction in the cost of maintenance of ten locomotives as compared with steam locomotives.

Third—A material saving in the maintenance of the road-bed because of the absence of hammer blow, shouldering, rocking and skidding.

Fourth—A material increase in the weight of the train which could be hauled around a certain curve by a locomotive having a certain weight on drivers.

Fifth—A material increase in the load which could be started upon a certain grade by a locomotive having a certain weight on drivers.

Sixth—A material reduction in the dead load necessarily hauled by a steam locomotive, represented by the part of the steam locomotive and tender not on drivers.

Seventh—A very large increase in the number of trains of given weight and speed which could be operated from a given power-house compared with the series-parallel or cascade systems. Or, to state this another way, a very much higher rate of acceleration with the same maximum output from the power-house, the same conductors, the same weight per train and the same watt-hours per ton-mile than is possible with the series-parallel or cascade systems.

Eighth—As each locomotive unit can be equipped with any desired number of driving axles and any desired number of locomotives can be operated under multiple control, the amount of power which can be applied to a single train and controlled by a single operator is practically unlimited.

Ninth—Fifty per cent of the energy now wasted on friction brakes can be saved in the form of useful electrical energy restored to the system.

Tenth—The first cost of equipment will be very much less than that of any system, for equivalent service, which involves the use of substations.

Eleventh—The cost of haulage per ton-mile will be greatly reduced as compared with steam locomotives, especially because of the large increase in the weight of the train which can be hauled.

Twelfth—Difficulties due to electrolysis would be reduced to a minimum.

Cassier's Magazine for December contains a practical article on "The Preventing of Electrolysis of Underground Gas and Water Pipes." This takes up the subject and its remedies in different conditions, and the attempt is made to arrive at some definite conclusion for the prevention of this phenomena. Another article of interest to the engineer is "The Practical Limits to Refinements of Machinery," and Dr. Robert H. Thurston communicates an article on "The Engineer as Financier." Whatever the engineer may be called upon to do, he is finally judged successful or unsuccessful, accordingly as a task undertaken by him more or less effectively contributes to the securing of a profit in the commercial operation in which his work finds place. Doctor Thurston takes the engineer's sphere of labor into consideration in its evolution, and shows in what way he enters so largely into the commercial questions of the day.

All alloyed steels can be annealed by packing in airtight boxes or muffles and then placing them in the furnace and maintaining an even temperature of say about 1,200 degrees Fahrenheit for twenty-four hours, then permitting it to cool down slowly.

STEAM PIPE COVERING AND ITS RELATION TO STATION ECONOMY.*

BY H. G. STOTT.

INTRODUCTION.

An investigation of the best engineering practice in covering high-pressure steam pipes disclosed the fact that although several tests of the efficiency of different types of covering had been made, nothing had been done toward determining the most economical thickness and the most efficient method of applying the covering, when taking into consideration the resultant station economy.

Before awarding a contract for covering the steam pipes in the Manhattan Railway Company's power-house, a careful investigation and test of different types and thickness of covering were made under the author's direction, and the results proved to be so important that it is hoped this paper giving these results may prove of value to the members of this association.

METHOD OF TEST ADOPTED.

In order to get the necessary data it was decided to carry out a complete test of the various types of covering on the market, and also to investigate the effect of varying the thickness of the insulating wall.

The usual method of test previously used was the condensation method, but this method is subject to so many errors, due to variation in the quality of the steam supplied, the relative positions of the different samples under test in regard to the distance from the boiler, and the exact measurement of the surface exposed, etc., not to mention the tediousness in getting results, which would be perfectly fair to all competitors, that it was abandoned. After mature consideration, an entirely new method of test was decided upon which, the author believes, meets every requirement of accuracy and perfect fairness to all, while covering a wide range of temperatures, and so giving many points which, when plotted in a curve, would tend to show not only the efficiency of a covering, but at the same time indicate any errors in taking readings.

The method adopted is illustrated in diagram No. 1, and consisted in coupling up about 200 feet of two-inch iron pipe and mounting the same on wooden horses about three and one-half feet from the floor; the three lines of pipe being approximately four feet apart and four feet from the nearest wall, in order to avoid any errors due to heat connections and radiation.

Sections fifteen feet in length were marked off on the straight portions of the pipe, and so arranged as not to include any pipe couplings or bends; two feet from each end of each section heavy potential wires were soldered on to the pipe, and at the extreme ends of the pipe 1,500,000 circular mils copper insulated cables were soldered on, the openings in the pipe having been previously closed by means of a standard coupling and plug. One of these cables ran direct to one terminal of a 250-kilowatt, 250-volt, steam-driven, direct-coupled exciter, which was solely devoted to furnishing current for the test, and which could have its voltage varied within wide limits so as to furnish any current up to 1,500 amperes. The cable connected to the other end of the pipe was then connected to three ammeter shunts in series in order to enable the readings to be easily checked, after which it was carried through a circuit-breaker and switch to the other exciter terminal.

The pipe-covering test was carried on in a vault in which there was no source of heat and no possibility of draughts of air, and arranged so that the section in which the test was being carried on could be locked up in order to prevent interference with the test.

Invitations for bids were sent to all the principal pipe-covering manufacturers and jobbers, specifying that each one would be expected to cover one or more sections of the two-inch pipe for a competitive test, and that samples from the successful bidders' covering would be analyzed in the company's chemical laboratory, and no covering accepted which departed more than three per cent from this analysis.

A special Weston millivoltmeter was ordered, with which readings were taken from the potential wires, the latter all being brought to mercury cups on a testing table near which the ammeters were also located.

PRELIMINARY TEST.

Preliminary tests were made with a small current in order to establish the individual resistance of the eleven-foot sections between the potential wires; this current was then gradually increased and more readings taken together with thermometer readings from thermometers having their bulbs in contact with the pipe at an angle of about thirty degrees, the stems projecting through the covering. From these readings a coefficient of 0.4649 per cent increase of resistance per degree centigrade was determined, and afterward used in determining temperatures of the various sections. At first it was thought that temperatures could be determined with sufficient accuracy by the thermometers inserted as above described in the centre of each section covered, but after a preliminary series of readings this was abandoned as inaccurate, owing, no doubt, to the variable contact made by the bulb on the bare pipe. All temperatures were, therefore, calculated by the resistance method.

Current sufficient to heat the pipe to

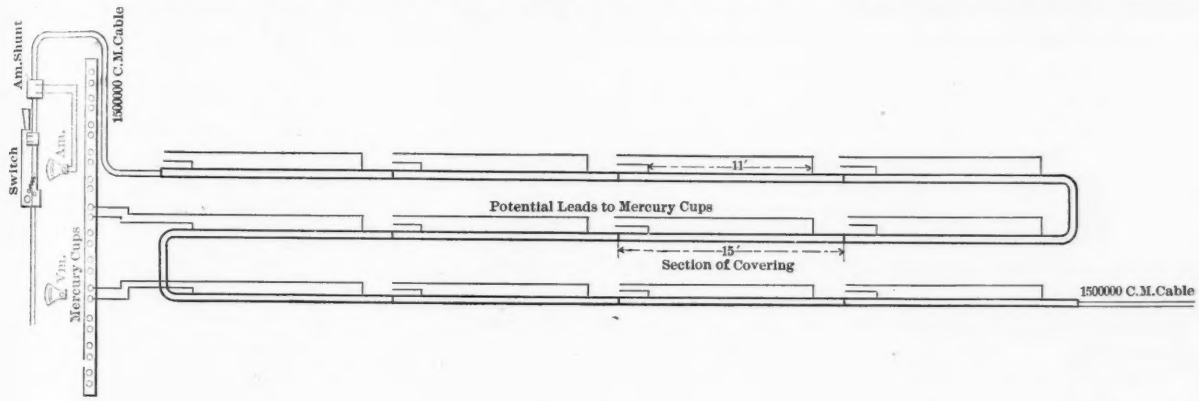


DIAGRAM NO. 1.

*Read before the Association of Edison Illuminating Companies at its twenty-third convention held at the Mount Washington, New Hampshire, September 9, 10 and 11, 1902.

approximately 370 degrees Fahrenheit (corresponding to a steam gauge pressure of 160 pounds) was kept on for three days continuously in order to dry out the various coverings, after which they were allowed to cool off to the air temperatures before starting the test.

The temperature of the room was kept between twenty-seven degrees centigrade, and thirty-one degrees centigrade during the entire test, each section had about 600 readings taken, and where any doubt existed in reference to readings, the entire series was gone over a second and third time with the gratifying result that it was conclusively shown that the test could be repeated with a variation of results not exceeding two per cent.

The method of test was to put a current of sufficient quantity through the pipe to heat it to, say, 220 degrees Fahrenheit, and keep this current on for a sufficient time to enable all sections to maintain a constant temperature (this period was found to be about ten hours) when readings of the millivoltmeter were taken on each section with simultaneous ammeter readings. As all the sections were in series electrically, the current was, of course, the same, so that no error could arise, due to variation of current.

The object of leaving two feet at the end of each section, or four feet between potential wires, was to avoid any error due to conduction of heat through the pipe. Tests were made to prove the efficiency of this precaution, and showed that no perceptible error was introduced.

A constant temperature having been obtained, it is evident that the watts lost in each section give an exact measure of the energy lost in maintaining a constant temperature, and from the watts lost the B. T. P. are readily calculated. Diagram No. 2 shows the result of the test values being reduced to loss in B. T. U. per square foot of pipe surface at various temperatures in the curves, and at a temperature corresponding to steam at 160 pounds pressure in the table.

After a series of readings had been completed, the current was raised sufficiently to give approximately fifty degrees Fahrenheit rise in the least efficient covering, and maintained constant for ten hours, when another series of readings was taken, and so on until the temperature of the pipe had reached a point far above anything used in practice. The extremely high readings were taken as a matter of interest, as they were got when the low efficiency coverings were only at working temperatures.

DESCRIPTION OF PIPE COVERINGS.

Referring to the table in diagram No. 2, the first column refers to the number of curve, the second column gives the name of the covering which, in most cases, is sufficiently descriptive, but a brief description of each covering may be of interest.

No. 2. Solid sectional covering one and one-half inches thick, composed of granulated cork moulded under pressure and then baked at a temperature of 500 degrees Fahrenheit, one-eighth-inch asbestos paper next pipe; finished with resin paper and eight-ounce canvas.

No. 3. Solid one-inch moulded sectional covering, composed of eighty-five per cent carbonate of magnesia; finished with resin paper and eight-ounce canvas.

No. 4. Solid one-inch sectional covering, composed of granulated cork moulded under pressure and baked at a temperature of 500 degrees Fahrenheit, one-eighth-inch asbestos paper next pipe; finished with resin paper and eight-ounce canvas.

No. 5. Solid one-inch moulded sectional covering, composed of eighty-five per cent carbonate of magnesia, outside of sections covered with canvas pasted on; finished with resin paper and eight-ounce canvas.

No. 6. Laminated one-inch sectional covering, composed of nine layers of asbestos paper with granulated cork in between; outside of sections covered with canvas pasted on, one-eighth-inch asbestos paper next pipe; finished with resin paper and eight-ounce canvas.

No. 7. Solid one-inch moulded sectional covering, composed of eighty-five per cent carbonate magnesia, outside of sections covered with light canvas pasted on; finished with resin paper and eight-ounce canvas.

No. 8. Laminated one-inch sectional covering, composed of seven layers of asbestos paper indented with one-quarter-inch square indentations, which serve to keep the asbestos layers from coming in close contact with one another; one-eighth-inch asbestos paper placed next pipe; finished with resin paper and canvas.

No. 9. Laminated one-inch sectional covering, composed of sixty-four layers of asbestos paper, in which were embedded small pieces of sponge, outside covered with canvas pasted on; finished with resin paper and canvas.

No. 10. Laminated one and one-half-inch sectional covering, composed of twelve plain layers of asbestos paper, with corrugated layers in between, thus forming longitudinal air cells; one-eighth-inch asbestos paper next pipe; sections wired on; finished with resin paper and eight-ounce canvas.

No. 11. Laminated one-inch sectional covering, composed of eight layers of asbestos paper with corrugated layers in between, the corrugations forming small air ducts radially around the covering; finished with resin paper and eight-ounce canvas.

No. 12. Laminated one and one-quarter-inch sectional covering, composed of six layers of asbestos paper with corrugated layers, forming longitudinal air cells, outside of sections covered with two layers of canvas pasted on; finished with resin paper and canvas.

No. 13. Solid one-inch moulded sectional covering, composed of a magnesia compound, mostly talc; one-eighth-inch asbestos paper next pipe; finished with resin paper and eight-ounce canvas. This sample was submitted for low-temperature work only, such as boiler, feed and drips.

No. 14. Solid one-inch moulded sectional covering, composed of magnesia compound, principally talc; one-eighth-inch layer of asbestos paper next pipe; finished with resin paper and eight-ounce canvas.

No. 15. "Remanit," composed of two layers wound in reverse direction with ropes of carbonized silk. Inner layer two and one-half inches wide and one-half-inch thick; outer layer two inches wide and three-quarters inch thick, over which was wound a network of fine wire, one-eighth-inch asbestos next pipe; finished with resin paper and eight-ounce canvas; made in Germany.

No. 16. Two and one-half-inch covering, composed of eighty-five per cent carbonate of magnesia, one-half-inch blocks about three inches wide and eighteen inches long next pipe and wired on; over these blocks were placed solid two-inch moulded sectional coverings, outside covered with canvas pasted on; finished with eight-ounce canvas.

No. 17. Two and one-half-inch covering, composed of eighty-five per cent magnesia; put on in a two-inch moulded section wired on next pipe, and over this a one-half-inch layer of magnesia plaster covered with canvas pasted on; finished with eight-ounce canvas.

No. 18. Two and one-half-inch covering, composed of eighty-five per cent carbonate of magnesia; put on in two solid one-inch moulded sections with one-half-inch layer of magnesia plaster between; two one-inch coverings wired on and

placed so as to break joints; finished with eight-ounce canvas.

No. 19. Two-inch covering, composed of eighty-five per cent carbonate of magnesia; put on in two one-inch layers so placed as to break joints and finished with eight-ounce canvas.

No. 20. Solid two-inch moulded sectional covering, composed of eighty-five per cent magnesia, outside of sections covered with canvas pasted on; finished with eight-ounce canvas.

No. 21. Solid two-inch moulded sectional covering, composed of eighty-five per cent magnesia, outside of sections covered with canvas pasted on; finished with eight-ounce canvas.

DISCUSSION OF RESULTS.

Nos. 2, 4, 6 and 15 were excluded by the specifications, which stated that "no inflammable material would be considered," but a test was made at the request of the manufacturers in order to give a comparison with the other materials.

It will be noted that two samples covered with the same thickness of similar material give different results—for example, Nos. 3 and 5, and also Nos. 20 and 21, though of practically equal thickness, show quite a perceptible difference in loss per square foot. Upon investigation, the cause of this difference was found to be in the care with which the joints between sections were made. A comparison between Nos. 19 and 20, showing two coverings having exactly the same total thickness, but one applied in a solid two-inch section, and the other in two one-inch sections, proved the desirability of breaking joints.

An attempt was made to determine the law governing the effect of increasing the thickness of the insulating material, and for all the eighty-five per cent magnesia coverings the efficiency varied directly as the square root of the thickness, but the other materials tested did not follow this simple law closely, each one involving a different constant.

The column on the right of diagram No. 2 shows the percentage of heat saved by the different coverings, compared to bare pipe, at a pressure of 160 pounds.

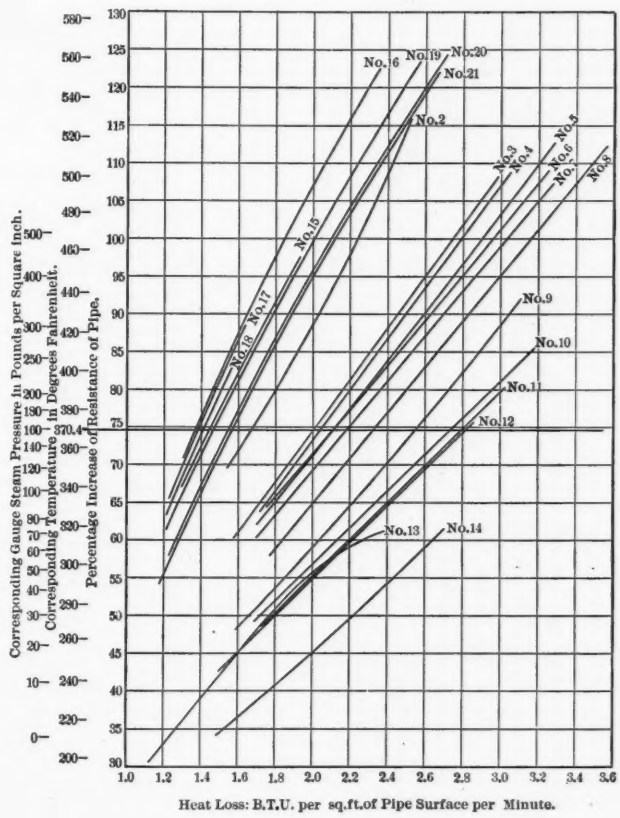
In another diagram an attempt was made to reduce all coverings to the same thickness, and thus show the relative efficiency of different types of material at a wide range of pressures. One-inch covering was adopted as the standard, and only those coverings, nearly one and one-quarter inches thick, were used in the comparison in order to avoid errors in calculating the losses in materials which did not follow the square-root law closely.

It was shown that the carbonized silk covering is the most efficient, having a relative efficiency of 86.9, while a curve giving a comparative result for eighty-five per cent magnesia comes second with 84.2 per cent efficiency. The two other samples of eighty-five per cent magnesia showed efficiencies of 83.1 and 83.2 per cent, thus confirming in a remarkable way the results on the other sample.

RELATION TO STATION ECONOMY.

To determine which covering is the most economical the following quantities must be considered:

First—Investment in covering.



Second—Cost of coal required to supply lost heat.

Third—Five per cent interest on capital invested in boilers and stokers rendered idle through having to supply lost heat.

Fourth—Guaranteed life of covering.

Fifth—Thickness of covering.

From an inspection of the first three quantities it is apparent that the covering which shows a minimum total cost of the three at the end of a specified time is the best covering to adopt, for the loss in heat at the end of ten years may readily cover over three times as much as the first cost of covering. To enable this to be seen more clearly, another diagram has been constructed, all the necessary data being noted on it; only a general explanation of the diagram will be given.

A specific number of square feet of pipe surface has been used in working out the total cost, but it is evident that the curve may be used to determine the most economical thickness of covering, irrespective of the total amount of surface to be covered, as long as the cost per square foot of material for different thicknesses varies in the same manner as for eighty-five per cent magnesia, which has been used in calculating the values shown in the curves and accompanying tables.

As the geometrical dimensions of the covering are a function of the cost of the increased thickness desired, it will generally be found that increasing the thickness of the material will increase the investment in a manner similar to that shown in the curves for eighty-five per cent carbonate of magnesia.

An inspection of the curves shows that before deciding upon what is the most economical thickness of covering to be used, it is first of all necessary to know how long the covering is expected to last.

For example, suppose that a temporary plant is being erected which is not likely to be required for more than two years; a one-inch covering will be the most economical. For covering guaranteed for ten years, as required by the Manhattan Railway Company, one-inch covering would show a total cost of $53,663, while a three-inch covering would show a total cost of $38,668, making a net saving of $14,995 at the end of ten years, or $1,499.50 per annum, which, capitalized at five per cent, represents $29,990.

From the above example it will be seen that while pipe covering is a relatively small portion of the many problems confronting the engineer, yet its scientific solution will yield rich results out of all proportion to the time required to solve it.

I would only add that there seems to be no reason for the former practice of putting on different thickness of covering on different-sized pipes, excepting the mechanical difficulty of applying a very heavy covering to a small pipe. This difficulty can be overcome by putting the covering on in two separate layers, and this plan should be used on all sizes in order that the joints may be broken, as poor joints may reduce the efficiency of the best covering six per cent or more.

I wish to acknowledge the careful and painstaking manner in which Mr. Van Gelder, who had charge of the test and investigation, carried out the test.

The author hopes that the above data will prove to be useful to the engineer who is confronted with the problem of selecting the best covering for steam mains, and will feel that he has accomplished something if it enables the engineer to persuade the manager to spend $4,000 extra at the start in order to save $15,000 at the end of ten years, and have dry steam in the bargain.

The Interstate Independent Telephone Association.

The regular annual convention of the Interstate Independent Telephone Association will be held at the Auditorium Hotel, Chicago, Ill., December 9, 10 and 11. This convention, it is expected, will be the largest and most enthusiastic and important gathering of business men ever held in this country. Nine states embraced in the association contain over 3,000 independent exchanges, and nearly all of the factory and supply houses in the United States. The manufacturers and supply houses of Chicago have joined to entertain all those attending the convention in the finest style. Reduced rates have been secured on all railroads. This is on the basis of a fare and one-third.

The programme, as announced, is as follows:

Tuesday morning, December 9, from nine to twelve o'clock—A reception to members and friends by the executive committee and officers at the secretary's headquarters. The distribution of tickets to the banquet will be made at this time, and the time of the banquet will be announced.

Tuesday afternoon, December 9, from two to five o'clock—Address of welcome by Hon. H. S. Taylor, prosecuting attorney of Chicago; response by President H. C. Raney, Fairfield, Iowa; report of executive committee; report of secretary; report of treasurer; selection of nominating committee by the states to report on call of the president.

On Wednesday, December 10, the manufacturers and supply houses of Chicago will take charge of the delegates from nine o'clock until twelve.

Wednesday afternoon, December 10, from two to five o'clock—"Rates—Measured Service," George N. Bandy, Perry, Iowa; "Sliding Scale Rates for Exchanges," Dr. H. S. Herr, Ottumwa, Iowa; "Toll Rates," H. H. Robinson, Cleveland, Ohio. Discussion. "Restrictions by Municipal Authority and Synopsis of the Law"—Ohio, W. F. Laubach, Akron; Iowa, U. S. Alderman, Nevada; Wisconsin, J. C. Harper, Madison; Minnesota, E. E. Webster, Minneapolis; Michigan, J. B. Ware, Detroit; Indiana, E. W. Pickhardt, Huntingburg; Illinois, M. Savage, Champaign; Missouri, H. Linton Reeber, St. Louis; Kentucky, D. L. Pendleton, Winchester. Discussion.

Thursday morning, December 11, nine to twelve o'clock—"Settlement of Toll Business Between Connecting Companies," A. L. Hutchinson, Weyauwega, Wis.; "Enforcement of Message Time Limit," H. E. Ralston, Maitland, Mo.; "Independent Telephone Securities as an Investment," (*a*) "From a Banker's Standpoint," Colonel J. D. Powers, Louisville, Ky., (*b*) "From a Small Investor's Standpoint," J. H. Layne, Carthage, Mo.; "The Berliner Patent, Bell's Claims of Infringement, Litigation now Pending," J. J. Nate, Chicago, Ill.; "Suggested Improvements for Improving Long-Distance Telephony," C. E. Hull, Salem, Ill.

On Thursday afternoon, December 11, from two o'clock on, the Chicago manufacturers and supply houses will take charge and entertain the attending delegates.

The officers of the Interstate Independent Telephone Association are: H. C. Raney, president, Fairfield, Iowa; I. A. Lumpkin, vice-president, Mattoon, Ill.; E. M. Coleman, secretary, Louisville, Ky.; J. C. Harper, treasurer, Madison, Wis. The executive board are: H. K. Cole, Owensboro, Ky.; J. H. Ware, Detroit, Mich.; Charles E. Hull, Salem, Ill.; George N. Bandy, Perry, Iowa; J. W. Layne, Carthage, Mo.; A. L. Hutchinson, Weyauwega, Wis.; L. A. Frazee, Connersville, Ind.

THE UNIVERSAL EXPOSITION OF ST. LOUIS, 1904.

TO COST $50,000,000, AND TO BE ALMOST TWICE THE SIZE OF THE CHICAGO EXPOSITION.

BY W. E. GOLDSBOROUGH.

The achievements, history and possibilities of electricity are to receive special attention and extensive treatment and display at the Universal Exposition of St. Louis in 1904. The authorities of the exposition have given the science and industries of electricity a place of the first order in the classification of the exposition. It has been made one of the principal departments, and arrangements and appropriations have been provided on a scale that should ensure to the country and to the world the greatest electrical exhibit that has ever been assembled for public and expert inspection.

This seems a significant and extraordinary statement and must imply an extensive general plan for the exposition. All of which is true. And in this connection it should be mentioned that a mistaken idea exists generally of the scope and importance of the St. Louis Exposition. It does not seem to be understood that the Universal Exposition of St. Louis in 1904 is to be the most important and extensive universal and international exposition ever held. This, however, is the case, and too much attention can not be directed to the words international and universal, as they really describe the nature and scope of the St. Louis Exposition. It is not to be a local or territorial or even a national exposition, as some may imagine. It is to be a world's exposition—a universal exposition in the fullest sense, and, as stated, the most extensive and important that the world has seen.

These facts should be thoroughly digested by the country, especially by prospective exhibitors; and they will be, as the knowledge of what is being done at St. Louis gradually forces itself upon the press of the nation.

TO COST ALMOST TWICE AS MUCH AS CHICAGO EXPOSITION.

The St. Louis Exposition is to be practically a $50,000,000 exposition. Consider what this will mean for the public in the way of a world's exhibition to visit and inspect, study and delight in, especially when the splendid Columbian Exposition at Chicago involved a total outlay of only $30,000,000, and when it is known that the experience in exposition building makes it fully possible to

make four dollars yield as much to-day in such work and construction as was got out of five dollars in 1893. These facts will make the St. Louis Exposition of almost double the elaboration, importance and interest presented to the world by the great Columbian Exposition of 1893.

There is already about $18,000,000 appropriated for the St. Louis Exposition by the city, state and national governments—the amount about equally divided from each source. To this add $10,000,000 which, at the very least figure, will be spent from the gate receipts and concessions—applied in advance to beautifying and perfecting the exposition—another $10,000,000 which will be used by participating governments, $5,000,000 by the states and territories of this country, and $5,000,000 by exhibitors at the exposition, and you have $48,000,000 already applied in making a colossal exposition, without having touched the millions that will be spent in the amusement, concessionary and other extensive features of the exposition. The Government appropriation, alone, for the St. Louis Exposition is about $7,000,000. For the Chicago Fair the Government appropriation was $2,500,000.

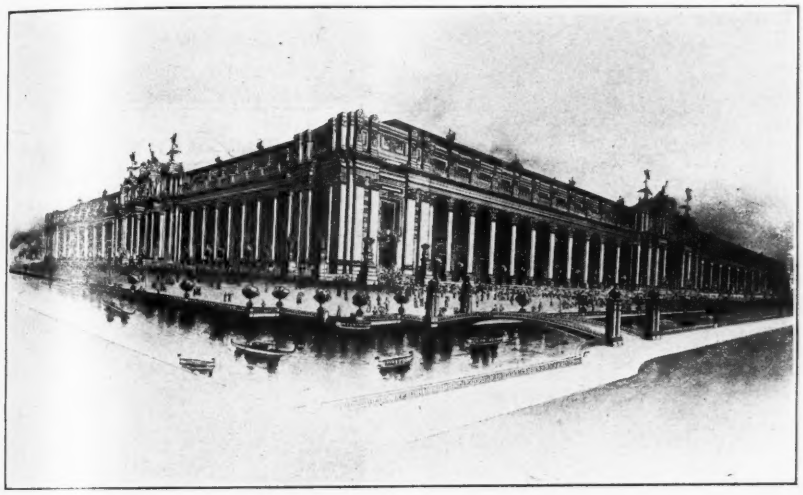
EXPOSITION SITE 1,200 ACRES.

The site of the exposition embraces 1,200 acres, this of splendid park territory adjoining further rich park territory on one side, and splendid rolling country and stretches of palatial residences on the other approaches. The Chicago Fair site embraced something over 600 acres—little over half of what is to be employed in St. Louis.

A comparison of the number and sizes of the various buildings of the two expositions will show in further relief the superiority of the St. Louis Exposition over that of Chicago, which to date is acknowledged to have been the most attractive and extensive held in the world.

MORE AND LARGER BUILDINGS THAN AT CHICAGO.

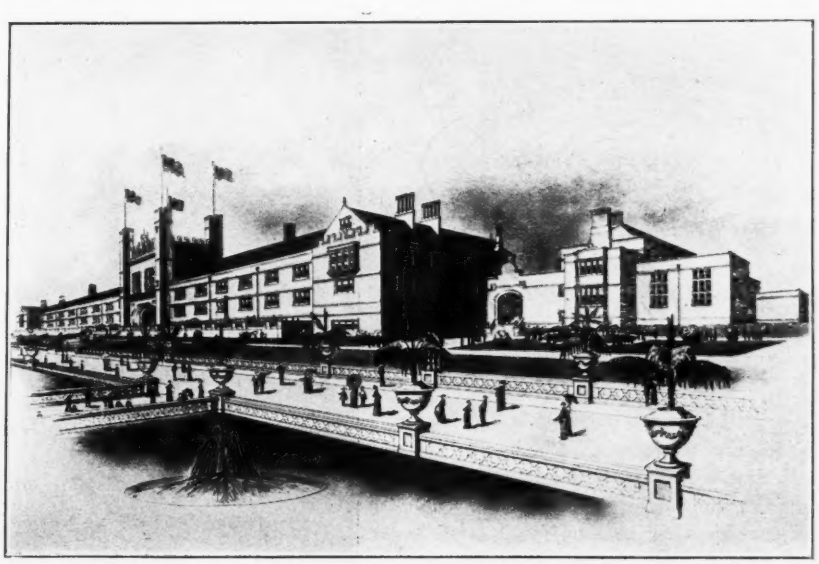
The Manufactures and Liberal Arts Building was the great structure of the World's Fair at Chicago in 1893—and it was truly colossal and impressive. It covered about thirty acres, its dimensions being 787 by 1,687. It housed a considerable part of the exhibits of the exposition. To enclose this same class of exhibits five buildings will be provided in St. Louis, covering an area of forty-three acres, almost one-third more than was used at Chicago. The separation into distinct buildings is for purposes of higher classification, for which the St. Louis Exposition will be noted. The Agricultural Building of the St. Louis Exposition will cover 500 by 1,600 feet, or nearly twenty acres; that at Chicago was just half this size. The Mines and Metallurgy Building at the St. Louis Exposition will cover 400,000 square feet; that at Chicago covered 245,000 square feet. The Transportation Building at the St. Louis Exposition will cover 720,000 square feet, nearly three times as much ground as covered by the splendid Transportation Building at Chicago, not including the annex, *viz.*, 245,760 square feet. It covers considerably more space than the building and annex (train sheds) at Chicago combined. At St. Louis there is to be an Education Building which will cover an area of about 400,000 square feet; Chicago had no building for education, nor has any other exposition had such a building. The Electricity Building at St. Louis will cover about 300,000 square feet; that at Chicago covered 250,000 square feet. Altogether the exhibit space under roof at the St. Louis Universal Exposition will approach 250 acres.



TEXTILES BUILDING, LOUISIANA PURCHASE EXPOSITION, ST. LOUIS, MO., 1904.

Some seem to have the idea that the St. Louis Exposition is to be similar to the Pan-American Exposition. This misapprehension will easily be dispelled by an acquaintance with the fact that any one of the four larger buildings at the St. Louis Exposition will cover more space than all of the exhibit buildings of the Pan-American Exposition. When it is contemplated that there are to be sixteen of these splendid palaces—exhibit palaces—such as are described above within the exposition grounds at St. Louis, some idea may be had of the immensity of the physical aspect and tremendous scope and variety of this Universal Exposition.

Taking this in connection with the amount of money available, it will be easy to understand how this exposition will constitute the grandest spectacle of architecture and the greatest array of interesting exhibits, instructive, entertaining, amusing, ever assembled for the review of the world. And the universal and phenomenal prosperity of the times will undoubtedly ensure to it a phenomenal attendance.



ADMINISTRATION BUILDING, LOUISIANA PURCHASE EXPOSITION, ST. LOUIS, MO., 1904.

Wireless Telephony by the Collins System.

By A. Frederick Collins.

WHILE experimenters have been striving for many years to produce a practical method of transmitting signals without connecting wires they have given comparatively little attention to wireless telephony.

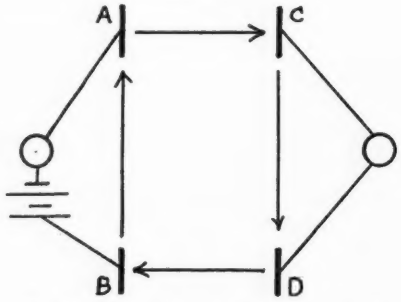


FIG. 1.—DIAGRAM OF THE CONDUCTIVITY SYSTEM.

The reasons for this are several, the foremost of which has been due to the fact that the gigantic obstacles in the way of the latter were believed to overbalance its value, *e. g.*, any kind of an electric current, direct, alternating, interrupted or oscillatory, may be utilized in the sending of a message by the dot and dash code, but in the emission, propagation and reproduction of articulate speech an alternating current having the same phase, amplitude and frequency at either end, *i. e.*, syntonized and synchronized, is necessary.

Again, it is only within the last few years that instruments of the desired sensibility and construction could be ob-

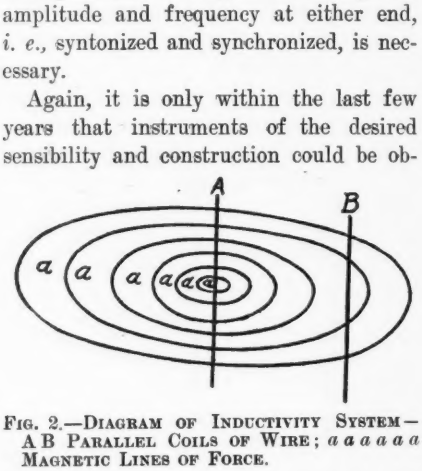


FIG. 2.—DIAGRAM OF INDUCTIVITY SYSTEM—A B PARALLEL COILS OF WIRE; *a a a a a a* MAGNETIC LINES OF FORCE.

tained, owing to a lack of knowledge of the requirements of the art, and after these matters were partially cleared up the question arose as to whether or not a wireless telephone would have a commercial value, and like many other evolutionary devices there are to-day many engineers who can not see in it the importance attached to it by its inventor. While this is discouraging in the extreme, work has been carried on for the past three years in order to demonstrate to the technician and layman alike that it has a special sphere of action, and this happy day does not seem to be very far distant. It may be argued by some that wireless telephony had been accomplished by others and this is admitted, but before describing the theory and system devised by me let us cast a retrospective glance at the several other methods by which this may be accomplished.

The best known method for transmitting energy to a distance by the natural medium is by the conductivity system and has been in vogue for nearly 100 years; as early as 1825 James Bowen Lindsay telegraphed across the River Dee in Scotland. Morse received it in this country in 1842; and by substituting a telephone transmitter and a receiver for the ordinary key and galvanometer or sounder, articulate speech may be carried on.

This is done by arranging four metal plates in parallel, as shown in the diagram, Fig. 1, where AB are connected with a transmitter and battery in series

FIG. 3.—WIRELESS TELEPHONE PORTABLE TRANSMITTER AND RECEIVER.

FIG. 4.—PORTABLE EQUIPMENT FOR FIELD USE—SENDING AND RECEIVING A MESSAGE.

with CD, while the distance between AC and BD represents the distance over which speech or signals are to be sent without wires.

By this method Preece, of England, succeeded in transmitting speech eight miles without connecting wires, but, see now, the conditions which made this experiment possible was a length of wire twenty-five miles long joining AB and CD, so that as far as a commercial wireless telephone was concerned, the limitations began before the practicability of the scheme commenced. Mons. Moche, in his recent experiments at Monte Carlo, and Mons. E. Ducretet, in his tests with wireless telephony at the Catacombs, employed this method.

There is another and far more ideal method for transmitting speech without wires than the one described and in which no earthed connections are used; this is the inductivity method. Preece advocated it for space telegraphy, and by careful deductions it was believed possible to transmit signals—not speech—across the Atlantic Ocean provided a coil of wire large enough to include the whole area of England were suspended on poles, and to include the state of New York within a similar coil, but some exceedingly pretty experiments may be performed in wireless telephony with two coils of wire, represented in Fig. 2, by the side elevation AB, having a considerable diameter and arranged parallel with each other not too many feet apart.

When an intermittent or an undulatory current flows through the coil A, the magnetic lines of force emanate at right angles to the coils themselves, and some of these lines thread through the coil B, setting up currents of the same frequency and amplitude, though the impressed potential and current strength will be, of course, much smaller than that emitted, following the well-known law of induction.

Alexander Graham Bell ascertained several years ago that the human voice could be reproduced with exactness by varying the intensity of a ray of light; this was done by causing it to fall on a concave mirror of small diameter attached to the diaphragm of a telephone transmitter, and then, by a series of lenses, concentrating the light and projecting it to a given point where the impinging waves acted on a selenium cell, and this gave rise to varying currents in a local circuit, including a telephone receiver.

Ruhner, of Germany, has improved upon the radiophone to such an extent that he is enabled to send wireless telephone messages a distance of four miles, but the enormous size of the equipment required, and the fact that propagation is impossible unless the transmitter and receiver are in a direct visual line having no intervening obstruction, render it of little more value than the interest attached to it from a scientific standpoint.

Since light waves utilized in the Bell radiophone are of the order of trillions per second it would not seem, on the face of it, to be a very hard proposition to employ Hertzian waves of the order of millions per second, for light waves and electric waves are both transverse vibrations and travel with the same rapidity. But theory and experiment have shown wireless telephony to be exceedingly difficult by the Hertzian wave method; this is due to the gradually decreasing maximum of an oscillatory discharge, whereas a pure sine wave is required, and, again, that the oscillations of current are in phase with the vibrations of the diaphragm, the circuit which emits the waves must be slowed down by the addition of capacity and its relation to inductance sustained by the proper coils, when the telephone receiver will respond directly to the waves without a special wire detector in connection with it. Professor Fessenden and the author have both experimented with this form of wireless telephone, and the results are exceedingly interesting from a scientific viewpoint.

Having tested all the above principles to find the one best adapted to wireless telephony, I found a method for obviating the difficulties encountered in utilizing such rapid oscillations as the disruptive discharge of an induction coil produces and without employing condensers or coils for obtaining resonance in the circuits, but by simple transformation only.

FIG. 5.—WIRELESS TELEPHONE FIELD EQUIPMENT—PLACING THE EARTH PLATE.

In experimenting with electric waves when employing a coherer adjusted to its maximum sensitiveness I have frequently found that a difference of potential occurs sufficiently great to break down its resistance, when low-frequency, high-potential currents surge through the arms of the oscillator system and emit exceedingly long electric waves. The emitted and propagated waves are of necessity long, for the wave-length depends on the rate of alternation or period of oscillation, as the case may be, and these reversals of current are bound by the coefficients of the circuit—inductance, capacity and resistance—and finally these

are governed by laws relating to the ether.

In my system of wireless telephony the discharge of low-frequency, high-potential currents is permitted to restore the electrical equilibrium or zero potential in the earth, that is to say, the discharge takes place in the earth, in contradistinction to a disruptive discharge which occurs in free air, and the former produces some phenomena which seem to me to be new.

For instance, the proper inertia for the propagation of electric waves seems to depend largely upon the length of the wave which passes through it. Light waves being exceedingly short find in clouds an obstacle, though red light waves will penetrate fog much more easily than the shorter ones of blue or green because they are longer. Marconi has observed that electric waves, a kilometre or more in length, penetrate fogs with apparent little loss of energy, and the evidence at hand tends to prove that long electric waves will traverse gross matter, like the earth, much more easily than they will free air.

This may be attributed to the apparent modification of ether when related to gross matter, for it is generally accepted that the density of ether when closely allied with an atom of matter is greater than ether in vacua, and the density of the ether surrounding the atoms of which the earth is composed renders it especially conductive to the emitted waves of my wireless telephone transmitter and the experiments I have made fulfill the requirements of this theory quite nicely.

As an analogue we have in the realm of sound an experiment which will serve to make this clearer. A good many years ago, it may be remembered by some, when it was our wont to go to the "ole swimmin' hole" we would perform a little feat in physics by striking two stones together in the water and the clicking would be heard many times farther and much more distinctly than when struck in free air, for dense mediums transmit sound waves to greater distances than those less dense. On this principle the late Professor Elisha Gray devised his submarine signaling bell.

In a homogeneous medium, such as water, the bound ether will transmit long electric waves farther, better and with less distortion than in a heterogeneous medium such as the earth itself, and so water becomes the best medium for wireless telephony as well as for wireless telegraphy. But wireless telephony is by no means confined to water, and until recently all the experiments and tests were made on hilly lands.

FIG. 6.—WIRELESS TELEPHONE FIELD EQUIPMENT—PACKING THE APPARATUS IN DRESS SUIT CASE.

An illustration of my wireless telephone mounted for field work is given in Fig. 3. It includes a transmitter and a receiver. The primary of the sending induction coil is in series with the transmitter, battery, variator and key. The terminals of the transformer are connected to the earth and a compensating capacity. Bridged across the terminals of the secondary is a Leyden jar condenser. The receiver is formed of a closed circuit having the telephone receiver, a single dry cell and the secondary of a transformer in series. The primary of the transformer is earthed as in the case of the transmitting secondary of the induction coil.

Fig. 4 shows my assistant in the field transmitting and receiving a wireless telephone message at Congers, N. Y. In ordinary practice the waves are radiated in every direction, but it has been found possible to direct them within ten or fifteen degrees of arc. Fig. 5 shows how the earth-plate is placed, and Fig. 6 the portability of the apparatus.

My experiments in wireless telephony were begun in Philadelphia in the fall of 1899, and in 1900 I sent and reproduced speech electrically through the earth a distance of 200 feet. Narberth, Pa., was then selected as a desirable place for testing stations, and in 1901 apparatus was constructed and tried across the Delaware River at a distance of a mile, and in 1902 this was extended to three miles; the instruments were located on two hills, with a valley, stream, quarry, railroad, telephone and telegraph wires intervening. The reproduced voice was faint, but the articulation was not distorted.

At the present time experiments are being made constantly at Rockland Lake, N. Y., and while it has not been attempted to increase the distance cited above, the instruments have been wonderfully improved with the result that the articulation is clear and loud enough for commercial purposes.

Another feature that has been added in the way of making the system commercial are bells at both stations which are operated wirelessly, and I believe that this is the first complete wireless telephone equipment constructed, operating

in both directions, together with signaling apparatus.

The value of wireless telephony lies in its application to speech transmission between vessels, supplanting the time-honored and hoary steam whistle. It may be used in isolated cases where bodies of water intervene and where cables would prove too expensive. It may be used where the right of way can not be obtained for erecting poles or stringing wires; there are a thousand places where it will be welcomed, but as a block signal system for vessels in harbors it will, in my opinion, find its proper sphere of usefulness.

My wireless telephone may never supplant the wire system now in use, but it can to-day be employed where the wire telephone can not be used—on the water and other inaccessible places. Nearly all wrecks are the result of colliding vessels in harbors, due to a misunderstood signal. But when those vessels are equipped with my system—as I hope they may all be soon—the captains will be placed in the same relative position as the modern business man, and they will be able to communicate with each other while sitting in their cabins or from the bridge, instead of relying on a system of signaling that should be relegated to the dead past.

Congers, N. Y., November.

The Mechernich System of Magnetic Concentration.

The ore is delivered by an adjustable chute between two magnetic poles, the upper one of which (the north pole) is rotated. As the ore arrives in the magnetic field the permeable particles are attracted by the north pole and are carried around by it into zones of progressively diminishing intensity until the centrifugal force imparted to the particles overcomes the magnetic attraction and they fall into collecting chutes, being classified according to their magnetic properties. The non-magnetic material falls directly into a chute close against the lower pole. This arrangement is claimed to have the advantages of dispensing with belt carriers, which weaken the magnetic field, and also of permitting the use of small magnetic fields and very narrow air spaces, thus minimizing the loss of energy and making it possible to attract feebly magnetic particles by a very weak current. The rotating pole being the only moving part of the machine, wear and tear is very small. In separating blende and siderite from the Upper Harz, the grains being of 0.5 millimetre size, 98.7 per cent of the zinc has been recovered. With dolomitic Silesian blende of two to three-millimetre size, the recovery was 91.8 per cent, which was increased to 93.5 per cent by reducing the grains to two millimetres. In treating ore from Broken Hill a yield of eighty-one per cent of the lead and sixty-nine per cent of the zinc was obtained.

THE DESIGNING OF TELEPHONE APPARATUS—X.

BY W. A. TAYLOR.

The Switch-Hook—The switch-hook, hook-switch or gravity-switch, as it is called, is a very important part of the telephone, inasmuch as it is apt to give

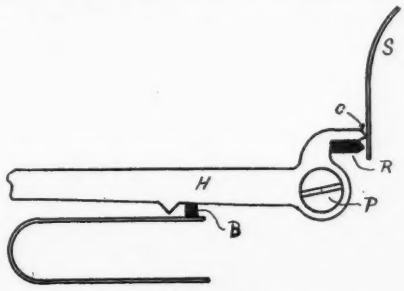


FIG. 25.

a considerable amount of trouble if of poor design. Through this switch all the contacts of a telephone are made so far as the talking circuits are concerned. When the receiver is on the hook the switch must be depressed sufficiently to permit the battery and secondary circuits to be opened, and the bell circuit must at the same time be closed positively so there can be no doubt of a good contact. Then when the receiver is removed from the hook the switch must rise far enough to make a good contact with the primary and secondary contact springs. If the movement is very small, there is apt to be too little tension at the contact points, and a consequent cutting off is apt to occur. The switch-hook fortunately is the least trouble, which now occurs in telephones, as most factories are making this item correctly.

FIG. 26.

Fig. 25 shows a form of switch-hook commonly used by the Bell companies. H represents the hook or lever which moves on a pivot screw P. S is a spring which presses on a rubber block R when the receiver is upon the hook. When the

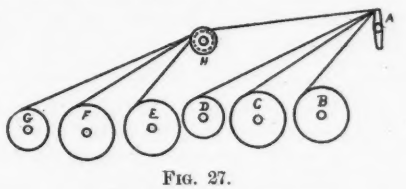


FIG. 27.

lever rises the contact is changed from the insulating block R to the contact C. The tension upon the spring S may be very heavy, as all that is necessary is a very small movement. The rubber block holds the tension of the spring back so that there can be no contact when not wanted. The contact points on the spring and also on the lever are of platinum. There are other switch-hooks made very similar, in which the rubber block is left out. In these forms the spring S can not have as great tension, or it will follow up the contact and will not break the connection. These will, of course, work, but the spring must be of heavier stock so as to make a heavier pressure with a smaller movement. There is a drawback to this style of switch-hook from the manufacturer's standpoint, as it is not self-contained. It is better to have a hook-switch which can be assembled complete before it is placed into the telephone on account of the expense of assembling in the magneto.

The springs for switch-hooks are generally made from German silver rolled hard. They should be cut or punched so that they lie lengthwise of the sheet. If cut crosswise the resilience will be poor. Phosphor-bronze has been used with good success by some makers, though it does not look as well. The contacts should by all means be of platinum, especially the battery contacts. Where a battery circuit is being made and broken, any other material will burn and cause trouble. Every time the current is broken a small spark may be seen. This spark is what causes the trouble. The design should be so that there is a slight rubbing whenever the contact is closed. If much rubbing occurs the contacts will be worn out quickly.

FIG. 28.

Many substitutes for platinum have been used with more or less success, but it has been found that they are apt to give trouble, especially on central energy apparatus where heavy sparking occurs.

The Condenser—In telephones, where the signaling is done by means of a battery placed in central office, it becomes necessary to find some means of presenting the flow of the battery current through the bells, at the same time the ringing current must pass through in order to ring the bells. For this purpose a condenser is used. The telephone condenser is not necessarily accurately made to a definite capacity, but should approximate about two microfarads.

Various ways have been adopted for making these condensers. The old way is shown in Fig. 26. It consists of alternate layers of tin-foil and paper. A represents the tin-foil of one side of the con-

denser, and B that of the other side. Between each layer of tin-foil are two sheets of paper. After the condenser is laid up in this manner it is thoroughly treated in hot paraffin and then placed under pressure until cold. This is a slow and uncertain method, and something had to be devised which could be made cheaper and produce as good or better results. The rolled condenser was made to take the place of the laid condenser, and this method is used almost to the exclusion of other kinds. In this style the paper and tin-foil come in rolls or spools and may be set up in a winding machine. The condenser itself is wound upon a flat arbor.

Fig. 27 shows a sketch of a machine similar to that which is used for this purpose. A represents a flat mandrel upon pivots and arranged to be turned by means of a crank. B and C are rolls of paper, D a spool of tin-foil, E and F paper and G tin-foil. In starting, three or four turns of paper from B and C are wound around the mandrel. A piece of very thin sheet brass is then wound in several turns of the tin-foil from D. The brass is for a terminal connection, and its shape is shown in Fig. 28. The little lug A extends out of the body of the condenser for the purpose of a connection for a wire. The brass piece with the end of the tin-foil is then laid on the mandrel and a turn is taken. Paper from spools E and F is then wound once or twice around the mandrel when the tin-foil from spool G is started. The paper from rolls E and F and the foil from G are passed over the guide spool H for convenience in winding. As many turns as necessary are then taken. The foil must be watched closely to see if it becomes torn or runs out of line. The tin-foil should be about one inch narrower than the paper, leaving a half inch of paper at each edge to prevent short-circuits. When the winding is finished the tin-foil from D is cut first, then the paper from B and C is cut about three or four inches longer. The other sheet of tin-foil is then cut about eighteen inches shorter than the remaining sheets of paper and another sheet of brass is wrapped into it for a terminal. The remainder of the condenser is then wound and there will then be several turns of paper over the whole.

Two sheets of paper are used between each sheet of foil, because one sheet would be likely to have holes in it which would cause a short-circuit. Small particles of metal are also imbedded in the paper now and then which would cause trouble. It is very unlikely with two sheets that two bad places will coincide.

A common width for the paper is eight inches and the tin-foil seven inches. The thickness of the paper is usually about 0.0008 of an inch, while the tin-foil is of various thicknesses from 0.0003 inch to 0.0015 inch. It is usual to call all foils used for this purpose by one name when a great deal of the foil is not by any means tin. The thicker foil is usually mostly lead, with just enough tin in it to make it roll well. The lead-foil can not be successfully rolled under 0.0008 of an inch, as under that thickness it becomes too flimsy to handle without tearing. It is easier to handle tin-foil at 0.0003 of an inch than the lead at 0.0008 of an inch. The lead is, of course, much cheaper by weight than the tin, but tin is lighter and a pound covers a much greater surface; consequently it is found to be much cheaper to use, as it is only the surface that counts. With the above size of tin-foil and thickness of paper, fifty-six turns make a condenser of approximately two microfarads capacity, provided that the condenser is treated in the following manner:

After the condenser is wound it is removed from the mandrel and placed in an oven where it is heated for a number of hours till it is as thoroughly dry as possible. Then it is removed and placed into a bath of hot paraffin. This paraffin is heated to a temperature of close on to 300 degrees Fahrenheit. This heat is sufficient to evaporate all the moisture which may still remain in the condenser. The condenser remains in the paraffin until bubbles no longer arise from it, when it is then removed to a press and all the surplus paraffin is squeezed out. The condenser remains in the press until cold, when it is removed and it is then ready for its case.

Such a condenser should have an insulation resistance of not less than 150 megohms, and may run very much higher. Many will test as high as 2,500 megohms. The condenser, when finished, will measure about eight inches long by four inches wide and three-eighths inch thick. The case used is generally of tin with the connections brought out on one of the ends. In order to prevent shaking about in the box paraffin is poured in at a temperature just warm enough to pour. If this paraffin is too hot it will heat the condenser and cause it to open up, thus reducing its capacity.

Guy Morrison Walker, the author of the description of China in the "Four-Track Series," No. 28, entitled "A Map of Asia and the Chinese Empire," has contributed to *Leslie's Weekly*, of October 30, an article on "American Labor's Debt to Railroads." In the opinion of railway authorities, this is one of the best of its kind ever written, stating in clear and concise English the intimate relation existing between the cost of transportation and wages. It is worthy of note that the average rate of freight per ton per mile in the United States is less than one-half the rate charged in any other country in the globe, and the average wages paid in the United States are very much greater than in any other country.

Electrical Patents

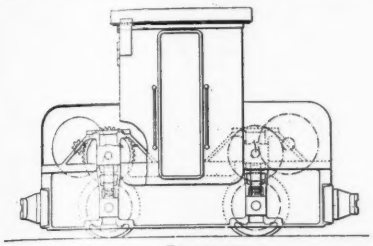
Mr. Willard M. Miner, of Plainfield, N. J., has devised means for overcoming the possibility of injuring the diaphragm in a telephone receiver by reason of its being unguarded from mechanical injury, and has obtained a patent theron, which he has assigned to the Sun Electric Manufacturing Company, of Camden, N. J. In attaining this object and obviating these difficulties, the large aperture usually employed in the receiver-cap is replaced by smaller perforations of such number, size and grouping as to attain a maximum of efficiency of the instrument, and at the same time leave a sufficient portion of the shell to adequately protect the diaphragm from injury. A very important additional function performed by the number of small perforations is their equalizing and refining effect upon the sound waves caused by the vibrations of the diaphragm. While the

TELEPHONE RECEIVER.

waves of ordinary amplitude pass through without encountering obstruction, those of greater amplitude, which would cause unpleasantly loud sounds in the ear, are impeded to a certain extent and are softened and divided so as to greatly lessen their unpleasant effects.

Messrs. Burnham Williams & Company, of Philadelphia, control a patent granted on a novel electric locomotive which is the invention of Mr. Ellwood C. Lindsay, also of Philadelphia. The object of the invention is to construct a locomotive for use on narrow-gauge tracks so that a large and powerful electric motor can be mounted thereon and geared to the driving mechanism. In the present instance the principal idea resides in employing a separate shaft located at one side of the wheels and geared to the axle so that the motor can extend entirely across the loco-

motive without interfering with the wheels. The frame is provided with the usual pedestals for the reception of the bearings of the axles which are provided with ordinary traction wheels. Directly above the pedestals are inverted pedestals for the reception of bearings in which is mounted an intermediate shaft. Extending from the axle bearings to the intermediate shaft bearings and rigidly connecting the same are bars or rolled sections, the construction being such that the frame is free to move independently of the bear-



ELECTRIC LOCOMOTIVE.

ings, while said bearings necessarily remain in the same relation with respect to each other. Springs are placed between the frame and the bearings so that the former may be yieldingly supported. On the intermediate shaft is a gear-wheel which meshes with another wheel on the axle, so that both shafts will turn in unison and preferably at the same speed, although when it is desired to increase or diminish the speed of the axle, the diameters of the gears may be varied as required. Mounted on the intermediate shaft is the frame of the motor having bearings for the armature shaft, and on this armature shaft is a gear-pinion which meshes with the gear-wheel on the intermediate shaft so that the motor drives the axle through the gear-wheels above described. By this arrangement the motor can be of any width desired, the limit being the width of the frames of the locomotives and the motor extending over one of the wheels. As already described, the locomotive is especially designed for narrow-gauge tracks, such as those around the yards of factories and mills or in mines.

A new method of making electric conduits has been patented by Amanda M. Lougee, of Boston, Mass., who has assigned her entire interest to the Clifton Manufacturing Company, also of Boston. The present invention relates to a method for manufacturing conduits in which there is an outside armor provided with an interior lining or insulating member formed as nearly as possible integrally with the armor. It is the primary aim of this invention to produce a conduit having its insulating member or interior lining and the armor or outside covering practically integral at all points without sacrificing any of the desirable qualities essential to a superior conduit. To this end there is first spread upon a suitable base or support, such as cotton fabric, a thin layer of asbestos, mica or other fire-resisting material contained in the vulcanizing vehicle or binding agent, preferably rubber, containing sulphur or other ingredients well known to the trade. This layer is made of a serviceable thickness and is extremely fireproof, containing its own hardening agents, so that when subsequently vulcanized it may be much thinner than has heretofore been possible. On this first layer is spread another layer of pliable material, such as rubber or the like, also containing sulphur or other vulcanizing agent, the result being that when vulcanized the hardest finish is given to the exposed surface and increasing pliability results between the parts. Having prepared the sheet as above stated, a cementitious coating is placed thereon, composed of some fluid solvent, such as naphtha, benzol, etc., bisulphide of carbon being preferably added and used therewith as a vehicle. Having prepared the armor and lining, the latter is properly inserted in the armor and is then forced radially outward at all points into direct contact with the armor by any suitable

ELECTRIC CONDUIT.

means, as a sectional mandrel, whereupon it is subjected to a vulcanizing heat sufficient to melt the cementitious layer or layers and perform the vulcanizing step of the process, thus completing the perfect union of the lining and the armor. Finally the fabric foundation is withdrawn in any suitable manner.

An Englishman, residing in Germantown, Pa., Mr. Henry H. Lloyd by name, has discovered an improved non-active metal for use in storage batteries. The Electric Storage Battery Company, of Philadelphia, has obtained a patent thereon. One object of the invention is to provide a "metal characterized by toughness, smoothness, resiliency and great strength in proportion to weight and adapted to resist when applied in connection with storage batteries the action of such acids as are usually employed even when accentuated by electrolysis. To this end the invention, stated in general terms, comprises non-active metal consisting of rolled antimonious lead. The non-active metal may be used as a lining for the tanks or even as a material from which to construct the tanks in which the plates are mounted and in which the normal action of the battery takes place, or, in other words, it may be used to make a holder for the electrolyte. The same properties or qualities, or some of them, which especially adapt it for these uses also adapt it for use as material from which to make the supporting grid or holder for the active material or material to become active of the plates. The non-active metal may be made by melting lead and antimony, of which latter there may be present from five to fifteen per cent, by weight, more or less (in actual practice excellent results have been obtained in the use of substantially twelve per cent, by weight, of antimony), and then casting the alloy. This has been done before, but the resulting metal when placed in the electrolyte of a storage battery corroded. Moreover, it was brittle, not flexible nor resilient, and was comparatively heavy in proportion to its mechanical strength, so that it could not be obtained or used in the form of sheets of that degree of thinness which is desirable for the support of many types of plates and also for the linings of many types of receptacles. However, according to this invention the antimonious lead which has been cast is then subjected to repeated cold rolling or equivalent forging, and the result upon it of the rolling is to materially change its characteristics and to make it useful for storage batteries in a way that it was never useful before, and, further, to make possible the production of types of batteries characterized by lightness, durability and strength, which could not heretofore be made. For example, extremely light plates could not be made on cast antimonious lead supports because of the weight of the latter necessary for sufficient mechanical strength. Consequently such plates were made on pure lead supports, which were corroded or formed, more especially near the terminals, which thus were detached. However, by the use of rolled antimonious lead supports such light plates can now be satisfactorily made. The effect of the rolling upon the cast antimonious lead is to entirely change its character, to remove it from the class of brittle metals, and to transfer it to the class of metals of which sheets of hard rolled copper are a good example—that is to say, the rolling replaces brittleness by elasticity combined with stiffness. It replaces small mechanical strength and great weight by great mechanical strength for little weight, and it resists tendency to corrosion when in use. The term "non-active metal" is used to describe a metal which, when subjected to the action that takes place in a storage battery cell, is not materially affected thereby, in contradistinction to metals which, under like circumstances, undergo changes which are referred to as "conversion into active material." As a holder for the electrolyte it possesses the mechanical strength which is lacking in pure lead, and it also resists the action of the acid better than pure lead would do and better than cast antimonious lead would do, and it is much lighter than either for the same strength."

Reviews of Current Engineering and Scientific Literature.

Giving Concisely the Substance of Important Papers in the Scientific, Electrical and Engineering Press of the World.

A Telephonic Detector of Hertz Waves.

In this communication Mr. F. J. Jervis-Smith describes a form of coherer which will work successfully in connection with a telephone receiver for receiving wireless telegraphic messages. Lodge has shown that a slender steel wire bearing against a metal surface was very sensitive to Hertz waves, but the combination was not self-decohering. Bleckrode found that steel needles resting on carbon blocks would act as a self-decohering coherer and could be used in connection with a telephone. The author has found that this combination is much more sensitive if the coherer has a slight vibration imparted. This is done by mounting the carbon blocks and the steel needles on a strip of thin wood. This was so attached to a Morse instrument that the roughened roller which feeds the paper touched the wooden support. In this way the contacts were slightly shaken and a slight buzzing sound was produced in the telephone. But when the system was influenced by Hertz waves the telephone gave out very clear clicks which could be heard four feet away. The apparatus was used also in connection with a secondary coil connected to the coherer through a condenser. A primary coil connected to two Leyden jars was used as a transmitter, and by it signals were sent a distance of one and one-quarter miles.—*Electrician* (London), November 7.

Metallic Films by Cathode Projection.

M. L. Houllevigne describes a method for obtaining metallic films on glass or other substances. The best method is to place the plate which is to receive the film upon the anode, and mount the cathode above it in such a manner that at a pressure of a few hundredths of a millimetre the dark cathode space just touches the plate. The current first of all clears the cathode of occluded gases. This process is particularly long in platinum, and especially in palladium. Then the substance of the cathode itself is projected and deposited partly upon the glass plate and partly upon the anode. The deposits may present all degrees of transparency and opacity accordingly as to whether the operation is continued for hours or for days. Bismuth so deposited does not show any change of resistance in a magnetic field, and is, therefore, probably perfectly amorphous. Iron shows magnetic rotatory polarization, but the author has not been able to find the double refraction announced by Righi.—*Comptes Rendus,* October 20.

Some Features of the Valtellina Railway.

This article by M. Cesare Pio gives a brief description of some of the details of this celebrated road. The Ganz system is used with three-phase distribution at 3,000 volts. An ingenious interlocking device prevents the motorman from touching any of the conducting wires or parts unless the trolley is first lowered. Power is furnished from the Adda River, 6,000 horse-power being available. Ganz turbines drive directly Schuckert alternators with revolving fields and giving 21,000 volts. No oil switches are used on the switchboard, but the switches are provided with copper horns for breaking the arc. These are twelve feet above the floor and are operated by ropes. There are two trolley wires suspended longitudinally. Transformer substations are located along the line containing 450-kilowatt, air-cooled transformers. The collecting device consists of two cylindrical rollers terminating in two small conical surfaces designed to work without at the switching points. The rollers are of phosphor-bronze and are fitted with ball bearings. Carbon contacts collect the current from the rollers. The locomotives have a tractive effort of 4,500 kilogrammes. In the motorman's cab are the following: An automatic circuit-breaker with fuses; a controller for starting and changing the speed; air-brake valve; valve for raising and lowering the trolley; controller for the air-compressor motor and indicating instruments. The cars are lighted, heated and ventilated with current at 120 volts taken from a small transformer. A diagram shows the connections in the car and details of the trolley are given.—*Electrician* (London), November 7.

Practical Dynamo and Motor Testing.

This is the first of a series of articles describing practical methods of carrying out a number of typical tests, how the measurements should be made, the calculations involved and the conclusions to be drawn from the results. The author first gives a number of practical hints in conducting experiments. It is always advisable to make a complete diagram of connections before making the actual connections. Any changes in actual connections must be made in the diagram. It is advisable to use thinner wires for branch circuits, both meter connections, etc. A switch should always be inserted in the main circuit. Attention is called to the change in the resistance of both armature and field windings of the dynamo with heat. The actual reading of every instrument must be recorded, as well as the true value, making a note of the instrument used. Errors are often produced by the vicinity of magnetic fields. The use of a calibration curve is advocated, and this must be checked repeatedly and at short intervals, as changes in the constant of the instrument may be caused by slight jars or other accidents. In taking a series of readings, it should be taken in sequence, with either increasing or decreasing values. Too much reliance should never be placed on a single reading or observation. All instruments, except electrostatic voltmeters, take a small amount of current. This fact should be borne in mind where the power to be measured is small. The necessity of adjusting instruments having a torsion head to zero before beginning the readings is pointed out. Some instruments, particularly those having shunts, alter their readings slightly after being connected to the circuit for some time. Readings of all the instruments should be taken simultaneously to avoid errors caused by fluctuations. The author then describes the shop method of measuring resistances, and the more refined method where the unknown resistance is compared with the known resistance. A number of valuable hints are given for this work, and a suitable method of tabulating results is shown.—*Mechanical Engineer* (London), November 8.

Changes of Specific Heat of Metals at Various Temperatures.

This article describes a new method of measuring the specific heat of metals

which has been devised by Herr W. Gaede, and is thought to secure great accuracy. The metals to be examined have a cylindrical form, and have a hole bored in one end which can be filled with mercury. If the metal forms amalgam, the hole is lined with a thin shell of steel. Within the mercury is inserted a resistance thermometer which can also serve for heating the body. This thermometer consists of a copper rod in which are embedded two wires—one of copper and one of constantine. These were carefully insulated from one another and the rod. In making the determination, the temperature is first measured, then a current is passed through the constantine wire, and readings taken of current, temperature and time. The body is enclosed within a calorimeter for this work. After correcting for radiation, the specific heat is obtained by dividing the electrical energy input, reduced to heat units, by the temperature rise and the weight of the body. Correction must also be made for the heat absorbed by the thermometer and the mercury. The accuracy of the method was determined by making a large number of observations under similar conditions. These showed that the extreme variation was one in one thousand. A table is given, showing the specific heats at different temperatures for antimony, lead, cadmium, copper, mercury, steel, zinc and tin. The tests on copper show that the specific heat is 0.09108 at 16.7 degrees and rises to 0.09403 at 92.3 degrees. For steel, the value is 0.10636 at 16.8 degrees, and increases to 0.11442 at 91.9 degrees. Solid metals show an increase in specific heat with temperature. Mercury shows a decrease with the temperature. The average specific heat for a range in temperature was found and compared with the corresponding values previously determined. In all cases there was good agreement, except for platinum. The values for platinum were determined in 1893, and it is stated that at that time absolutely pure platinum could not be obtained.—*Physikalische Zeitschrift* (Göttingen), November 1.

Leeds Electricity Works.

Electrical supply was first given in 1893, and its use has increased regularly. This article describes the extensions to the plant which have been found necessary to meet the increased demand. There are now about 180,000 lamp connections. The building is 290 feet by 180 feet and adjoins the river. The engine room is 220 feet by 65 feet and 33 feet high from floor to crane rail. The switchboard is in a separate room, 170 feet long and 28 feet wide. The boiler room is 231 feet long and 82 feet wide. Here there are eight Babcock & Wilcox water-tube boilers with superheaters and purifiers. Provision is made for sixteen more as they become necessary. Coal is stored in bins above the boilers and is fed to them by mechanical stokers. A Green economizer is provided. In the engine room there are one McLaren engine and one Belliss engine, each coupled to a 1,500-kilowatt alternator made by the Electric Construction Company. The engines are rated at 2,400 horse-power each and are of the triple-expansion type. The speed is 200 revolutions per minute. The generators are two-phase machines supplying energy at fifty cycles and 2,000 volts. The revolving field is thirteen and one-half feet in diameter and contains thirty poles. The guaranteed commercial efficiency is ninety-five per cent at half load. When one phase is carrying full non-inductive load and the other is unloaded, the difference in pressure will be but three and one-half volts. The exciter for each machine is mounted on the same shaft. The switchboard is of the latest Ferranti type with oil-break switches. All cables are run in a subway under the switchboard. The subway is extended 350 yards under the street for distributing the cables to the streets intersected. Transformer substations are provided through the city, reducing the pressure to 205 or 410 volts as may be desired.—*Electrical Engineer* (London), November 7.

Oil Motor Cars in 1902.

The paper read by Captain C. C. Longridge at a recent meeting of the British Institution of Mechanical Engineers aroused so much interest that it was decided to hold two extra meetings to continue the discussion. This is a report of the first of these. Mr. W. W. Beaumont did not agree with the opinion that the horizontal engine was better than the vertical. The vertical was better especially for high speeds. The simpler the valve gear the better, as economy was of little importance. It is undesirable to leave any residual gases in the cylinder, as they reduce the economy. A four-cylinder engine would give the same number of impulses in a revolution and would be simpler. He did not think hematite iron suitable for cylinders, as it would prove too brittle. Professor F. W. Burstall thought the igniter caused more trouble than all other parts. The magneto form was the best electric igniter. Coil and battery igniters were not satisfactory. The objection to the Diesel system lay in the enormous pressures required to ignite the heavy oils. It was necessary to keep the temperature of the cylinder low in order to prevent expansion of the air and a consequent diminution of the charge. It was necessary to use a scavenger charge to get rid of the burnt gases. A double-acting engine could be used and thus get an impulse every revolution. Mr. C. T. Crowden thought the car should be flexible and give with the inequalities of the road. Extreme high speeds above 600 were not desirable. He preferred the horizontal engine to the vertical. The flywheel should be placed parallel to the car-wheels, as this would steady it by its gyroscopic action. Differential countershaft and claims made a good transmission, and a belt with fast and loose pulley was better than a friction clutch. Lamp ignition was too dangerous to put on any car. Professor W. Robinson said that water was objectionable in a gas-engine cylinder, but beneficial if properly used with oil engines, as they then run steadier and cooler. Too much water interfered with ignition. The most economical piston speed was from 450 to 800 feet per minute for oil engines. By the use of fans and proper design, small motors could be run air-cooled. Mr. H. Austin thought a high-carbon steel better than a mild steel for wearing qualities. Solid cylinder heads were undesirable, as they tended to warp when heated. Cast iron was good for valves, and the valve should be lowered into the cylinder slightly. Mr. A. G. New had tried solid-drawn tubes for cylinders screwed into cast-heads, but the joints leaked. Cylinders stamped out of one piece were good, but too expensive, and the water-jacket was difficult to arrange. Mr. C. Rainey stated that the addition of water to the oil produced cooler and smoother running, and at the same time increased the power of the engine. The beneficial effects were maintained until the amount of water was equal to that of oil. More than that interfered with sparking. Premature ignition was not due to ignition. The ignition points might become red hot or a flame might persist in the valve ports. Mr. A. R. Sennett thought the effect of water should be worked out. He had found it valuable for preventing soot in boiler tubes.—*Engineering* (London), November 7.

INDUSTRIAL SECTION.

ILLUSTRATED DESCRIPTIONS OF NEW AND STANDARD ELECTRICAL AND MECHANICAL APPARATUS.

Constant-Potential and Multiple Enclosed Arc Lamps.

The great demand for a simple and reliable arc lamp, free from complication and of such construction that it can be manufactured in a durable manner without largely increasing the price of production, has been met, it is claimed, by the manufacturer of the lamp illustrated in the accompanying engravings. These lamps are 110-volt, constant-potential, and 220-volt multiple enclosed arc types. The solenoid is in the head of the lamp, within the canopy, and is easily accessible by lowering the canopy, which is accomplished by releasing the proper set-screws.

FIG. 1.—WEATHER-PROOF ARC LAMP FOR OUTDOOR USE.

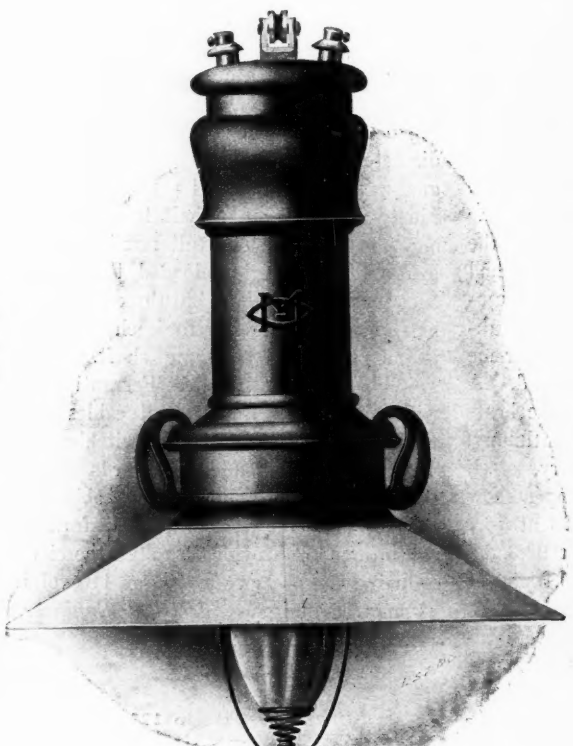


FIG. 2.—WEATHER-PROOF ARC LAMP FOR FACTORY USE.

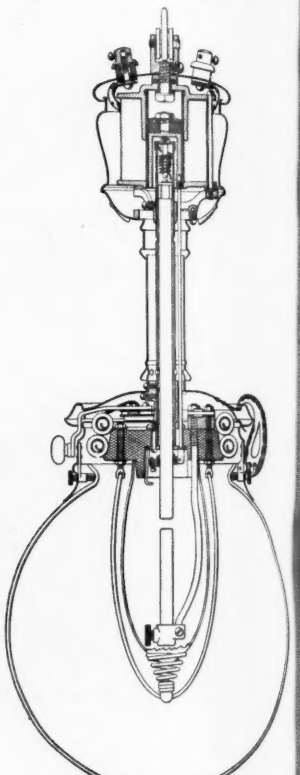


FIG. 3.—DETAILS OF MECHANICAL APPARATUS OF ARC LAMP.

The armature is connected directly to the clutch by means of a metal rod, and forms part of the plunger of the graphite dashpot, which is located in the centre of the magnet. The resistance is fastened around the base of the lamp, out of view, but exposed directly to a current of air, and is also thoroughly protected from the action of the weather. The clutch is reliable, simple and operated directly on the carbon. The portion in direct contact with the carbon is made of special insulated material, which ensures a steady clutch hold and freedom from burning out. The lamp switch is in the base of the lamp, and easily accessible. The contact for the carbon is by means of a flexible cable, thus eliminating all sliding contact.

The inner globe is pear-shaped and is open only at one end, being held firmly against the porcelain base by a spring, thus rendering the accumulation of explosive gases impossible. These globes are furnished in clear or light alabaster finish. The outer globe is of a bell-shape and is held by a globe ring to the lamp base. These globes are also furnished for a clear or light alabaster finish. The binding-posts are at the top of the lamp, safely separated and insulated by porcelain insulators from the case, and are marked P and N.

The accompanying illustrations give a good idea of the appearance of the lamp. Fig. 1 is a lamp with weather-proof case. Fig. 2 is a factory lamp with weather-proof case, and Fig. 3 is a section view of the mechanical details.

The 110-volt lamps operate on a constant-potential circuit having a pressure from 90 to 130 volts, consuming from four to five amperes, this variation being adjustable. The 220-volt lamps operate on a constant-potential circuit having a pressure of from 220 to 230 volts, consuming two and one-half to three amperes, the variation being adjustable. The type "OM" constant-potential series enclosed lamp on a direct-current circuit of 220-volt potential can be operated with two in series. The special combination lamp is constructed to work on a 220-volt circuit. If the circuit is of higher voltage than 230 volts, a separate resistance coil is furnished to be connected in series with the lamp. The special resistance coil is so constructed that by moving a lever switch either 230, 240 or 250-volt current can be used in the lamp without changing the resistance coil or removing from or adding any parts to the lamp. If the current is under 230 volts, the same switch is used to entirely cut out the resistance coil when the lamps work direct-connected to the leads. When two or more lamps are connected in series, each lamp does not require over seventy-five or eighty volts in the arc.

These lamps are manufactured by the Osborn-Morgan Company, of Cleveland, Ohio.

The Turbine Equipment at the "Soo."

The magnificent power station at the Sault Ste. Marie which was put into commission a few weeks ago is the largest example extant of the application and development of water power from a low head. While the preparatory work necessary to make this a successful installation did not call forth the combined skill and efforts of hydraulic engineers in all parts of the world, as did the Niagara Falls equipment, yet it took months of experiment and study before being perfected and as installed has at least one point of advantage over its great rival, in that the efficiency of the turbines is far ahead of the latter. The type of turbine

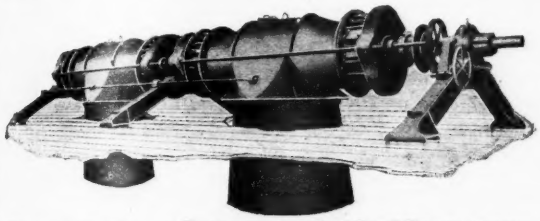


FIG. 1.—THE TYPE OF TURBINE AT THE "SOO" DEVELOPMENT

used in this equipment is the well-known McCormick turbine, which might well be termed the standard type in this country. When originally brought out, the tests made on it showed it to be one of the best in points of efficiency, power and speed of any of the turbines then on the market. While there have been other turbines designed since then, and all showing fine results, the McCormick still retains its popularity. The usual method of setting turbines has been to place the wheels so as to revolve in a horizontal plane, the shafts being vertical. With this advent, however, of expansion in the electrical fields, and the application of water power to the generating of electrical currents, it became necessary to set turbine wheels in a vertical position on horizontal shafts.

When the Michigan, Lake Superior Power Company prepared its plans for the new power-house, this setting was finally determined on as being the most economical, and proposals and plans were invited from turbine builders. Up to this time all tests of wheels had been made on a vertical step at the Holyoke Water Power Company's flume in Holyoke, which is at present the most reliable testing station, as it was designed by Francis and constructed by Clemens Herschel. This type of flume was used by Francis to obtain his formulæ for calculating water powers, which are authoritative today. To make tests on wheels in a horizontal setting required considerable expenditures, and an arrangement was finally entered into between the Power company, the Webster, Camp & Lane Company, and J. & W. Jolly, Holyoke, to design, build and test a turbine unit which should fulfill the following requirements: With a sixteen-foothead the unit must develop 568 horse-power at 180 revolutions with an efficiency of eighty per cent. Tests to be made at Holyoke under the supervision of Professor G. S. Williams, of Cornell University. After many months of experimenting with improved forms of wheels and various designs of draft cases and draft tubes, the final design as illustrated by Fig. 1 was adopted. The best results finally obtained were as follows: Head, sixteen feet; speed, 180 revolutions per minute; horsepower, 584; efficiency, 84 per cent. These figures speak for themselves.

The penstock unit, as shown in figure, consists of four turbines arranged in pairs with one draft tube for each pair. Each pair is keyed to an open-hearth hammered-steel shaft and the two shafts are bolted together by means of forged couplings. The shafts are designed to transmit double the power of the generators with the usual factors of safety. This is to provide against the torsional vibrations caused by generating an alternating current. Each pair of the turbines discharge into a central conical ended draft case, and the discharge is continued to the tail-race by means of a conical steel-plate draft tube. The draft cases are made of cast iron and are separable in a horizontal plane parallel with the turbine shafts, making them easy of access. The centre of each case is provided with a yoke or steady rest for the turbine shaft. The combined water-wheel shaft is supported by three heavy cast-iron pedestal girders that rest on the side or foundation walls of the penstock. The water bearings are amply large and are made from specially prepared wood blocks. These are backed with iron and can be adjusted for wear. The draft cases are supported by heavy spanning frames made from fifteen-inch steel I-beams. These also rest on the side wall of the penstock. This construction frees the arches over the tail-race from the weight of the machinery. The draft cases and pedestal girders are tied together on each side by longitudinal bars, making a substantial and ideal support for the running parts. The turbine shaft penetrates the curved bulkhead by means of a stuffing box properly secured to the steel plates by rivets. The common horizontal gate shaft extends through the bulkhead into the dynamo room in like manner, and is provided with the necessary rigging to manipulate the gates of the four turbines simultaneously by hand or by machinery.

The turbine shaft at the end farthest from the dynamo room is five and one-half inches in diameter and increases in size until it is seven and one-quarter inches in diameter at the dynamo end, and is arranged to be coupled to the horizontal dynamo. Each of the four turbines is encased in a balance gate curb, while the individual gates are so poised as to direct the flowing water properly and differently, at the different degrees of gate opening, maintaining a high efficiency.

Side-Cutting Pliers and Electricians' or Wiremen's Snips.

These tools are always interesting and have come to be an absolute necessity to the electrical world. There does not seem to be anything which can take their place, and the improvement and modification which may be made in their construction are entirely in the direction of making them of the required strength and of proper dimensions for the work they are designed to do. The accompany-

SIDE-CUTTING PLIERS AND SNIPS.

ing illustration shows a Swedish side-cutting pliers, with splicing clamps or connectors, manufactured by the Smith & Hemenway Company and the Utica Drop Forge and Tool Company, of New York. The jaws of these pliers are polished and they are finished with rounded edges. The characteristic feature of these pliers is that the cutting centre is one-third closer to the cutting edge than an ordinary box joint. This gives it greater leverage, making a quicker and easier cut. The second illustration represents what is claimed to be a perfect tool for cutting copper and insulated wire. The notches in the blade prevent the wire from slipping, and will cut with the least possible pressure. The blades are steel, laid, hardened and tempered. The backs are ground to a sharp edge for stripping insulated wire, and one point being round, the danger of injury from carrying them in the pocket is obviated.

A Universal Gas Engine Ignitor.

There is a growing demand for the use of gas engines in a great many varieties of electric station service. The gas engine, when properly constructed, is generally a very efficient machine, and the ignitor device is one if not properly regulated and taken good care of that will give considerable trouble throughout the operation of the machine. The accompanying illustration shows the application of a complete ignitor which is claimed by the manufacturer to possess points which make it very valuable for this class of service. The commutator handle is readily shifted for late ignition to start the engine, and after the engine is started, the lever may be placed so as to secure any point of ignition desired.

With this ignitor, no moving parts are on the inside of the cylinder, and this obviates the possibility of anything becoming gummed or sticky. The sparking plug screws through the cylinder wall into the combustion space so that it can be readily removed if necessary to inspect or clean. The spark jumps between the intervening points at the end of the plug, these points being about one-thirty-second of an inch apart, the spark taking place when the brushes come into contact with the copper strip in the commutator roll.

In adapting the igniter to a two-cycle engine, the balance-wheel is removed and the commutator handle ring is placed on the bearing sleeve, the same being followed with the gears. The gears are placed in mesh so that the copper bar in the fibre roller commences to touch the brushes when the piston is at a point nearest the cylinder head and the commutator handle is upright. Ignition is regulated by moving the handle backward or forward, the electrical connections being made as shown in the accompanying diagram. For four-cycle engines, a small sprocket is placed on the crank shaft, and the commutator supporting arm is attached at any convenient place on the engine or floor, so that the commutator sprocket will be in line with the crank sprocket. The chain is placed on the sprocket so that the copper bar in the fibre roller will commence to engage the brushes at the end of the compression stroke, the piston being at a point nearest the cylinder head, and the commutator handle placed in the forward position for a late ignition. The electric connections are made as shown in the accompanying diagram.

The vibrator on the spark-coil can be so adjusted that the greatest efficiency is shown by sparks thrown from end of wire to end of spark-plug when the wire is disconnected and the commutator brushes are on the copper strip. By using the secondary winding of the spark-coil (which causes the jump spark) and by the manner of connection designed by the company, a very hot spark is secured with considerable less battery force than usual. It is claimed that this ignitor is very frequently run with only two dry cells. In the case of the cycle engines, should it be desired to make a spark only as often as charge is drawn into the cylinder, the apparatus is constructed according to specifications which show whether the engine governs on the inlet or exhaust valve.

When the mixture of gas and air is in the cylinder of the engine, the crank is at an angle of forty-five degrees. The commutator brushes engage the copper bar in the fibre roll and it is only necessary to close the switch to cause a series of hot sparks to throw in the cylinder and the engine starts immediately. This apparatus is known as the Detroit Ignitor, and is manufactured by the Detroit Motor Works, Detroit, Mich.

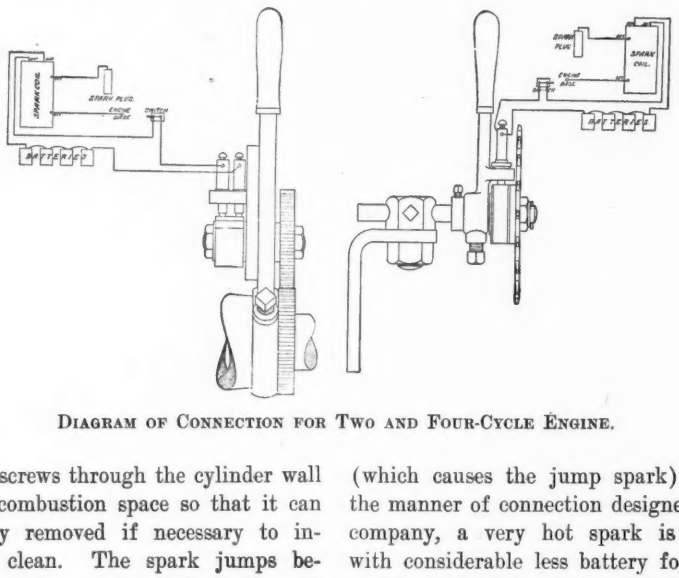
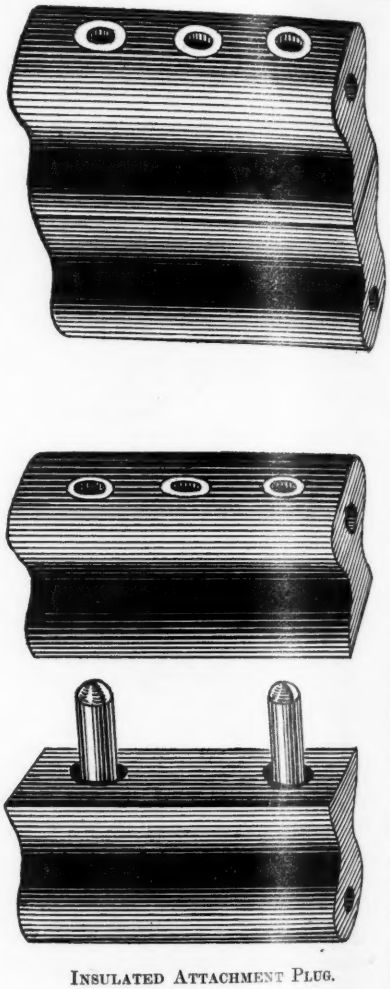


Diagram of Connection for Two and Four-Cycle Engine.

An Insulated Attachment Plug.

The plug shown in the accompanying engraving is especially suited for connections which have to be made and unmade frequently and rapidly. It is well adapted to theatrical work, for storage battery connections in electric vehicles, for trailer light coupling on electric railways, and for church chandeliers and theatres. This attaching plug is made of the highest grade of vulcabeston, and in capacities up to fifty amperes. The plug shown is for a capacity of twenty-five amperes. These plugs are manufactured by Joseph P. Menchen, New York city.



Insulated Attachment Plug.

Society of Chemical Industry.

The regular meeting of the New York section of the Society of Chemical Industry was held at the Chemists' Club, 108 West Fifty-fifth street, on Friday, November 21. The following papers were on the programme for the evening: "Uniformity in Analysis of Copper Slag," by Thorn Smith; "Constitution of Portland Cement," by Clifford Richardson; "Some Phases of Textile Chemistry," by J. Merritt Matthews. By title: "A Process for Rendering Phosphoric Acid Available," by Charles Baskerville; "Notes on the Determination of Water in Crude Oils," by M. Curtis and P. W. Tompkins.

CURRENT ELECTRICAL NEWS

DOMESTIC AND EXPORT.

TROLLEY LINE UP MONT BLANC—It is announced that plans have been submitted to the French Minister of the Interior for the construction of an electric railroad to the summit of Mont Blanc, on the Savoy side of the mountain.

LAYING A CABLE TO THE FARALLONES—The weather bureau officials have started laying a cable from Point Reyes to the Farallones. A station for meteorological observations has already been erected at the latter point. It is expected that a system of wireless telegraphy will soon be installed to take the place of the cable.

LARGE AWARD FOR POWER COMPANY—In the suit of the Holyoke Water Power Company against the City of Holyoke, Judge Lowell of the United States District Court, by agreement of counsel, has entered a decree in favor of the plaintiff, awarding the Holyoke Water Power Company $707,000 for the taking of its gas and electric light plant, and $18,000 for the rent of power necessary to maintain the plant.

GERMAN CABLE COMPANY'S BUSINESS GROWS—The statement of the German Atlantic Cable Company shows a considerable increase in receipts in consequence of the large traffic with America. General progress is being made in the company's plants, which are being fitted with the newest machines, to assure the making of perfect cables for under-sea use. A thousand kilometres of the second German Atlantic cable have already been manufactured.

BIG RAILROAD COMPANY FORMED—The articles of incorporation of the Metropolitan Street Railway Company, of Dallas, have been sent to the Secretary of State at Austin. The capitalization of the new company is placed at $4,500,000, and its incorporators are: C. E. Tripp, A. K. Bonta, Henry C. Coke, C. H. Byrne and John Frost. The object of the new corporation is to construct and maintain electric lines in Texas. Upon the adoption of these articles by the Secretary of State, should this come to pass, the largest company ever located in the city of Dallas will have sprung into being.

BELL TELEPHONE COMPANY DOUBLES ITS CAPITAL—The capital stock of the Bell Telephone Company was increased from $5,000,000 to $10,000,000 at a meeting of the stockholders of the company on November 15. The meeting was held at the office of Henry M. Watson, president of the company, a majority of the stockholders being present. Edward J. Hall, one of the directors of the company, acted as chairman of the meeting, and Joseph S. Baecher, secretary and treasurer of the company, was the secretary. President Watson stated after the meeting that the only action taken by the stockholders was that of formally increasing the capital stock as stated above. This company's headquarters are at Buffalo, N. Y.

A TROLLEY SCHEME FOR PORTO RICO—Three representatives of American capitalists have applied to the Executive Council for a franchise to develop the natural water power of the island. One of them, William Yeager, who acts in behalf of a Philadelphia concern, also asks for a concession to build an electric road from San Juan to Ponce in connection with the water-power scheme. The estimated cost of this road is $2,800,000. The council is not sanguine as to the commercial success of the projected enterprise and, therefore, demands a bond of from $150,000 to $200,000. The other two applicants, who own property along the streams from which it is proposed to derive the power, urge the impracticability of a railroad and ask for a power franchise alone.

BALTIMORE ELECTRIC LIGHT DEAL—The purchase of the $2,000,000 of common stock of the United Electric Light and Power Company from the United Railways and Electric Company by a syndicate, acting through the Continental Trust Company, has been concluded. For the stock, which constitutes the entire issue, $900,000 is to be paid on or before January 15, 1903. The purchase of the control of the Light and Power Company practically assures the launching of the great Susquehanna River electric power development project by the syndicate. There are to be three developments that will cost between $10,000,000 and $12,000,000, and two years will be required to complete the work, the purpose being to supply motive power for the street railway system of Baltimore, to supply electricity for lighting the streets and for general power and heating purposes.

BROOKLYN WIRES TO BE BURIED—Commissioner Robert Grier Monroe, of the department of water supply, gas and electricity, has issued an order to the effect that all telegraph, telephone and electric light companies in Brooklyn must place their wires underground at once. He also directed the Brooklyn Rapid Transit Company to place underground its feed wires and all other wires except the trolley wires. The commissioner has given the companies until May 1, 1903, to finish this work. Under the charter the companies have thirty days' grace beyond the date fixed by the commissioner, so that they actually have until June 1, 1903. The orders were issued by the commissioner after receiving a report from Professor George Sever, of Columbia University, who, as a consulting engineer, advised that such an order be issued. The order will effect an important change in the appearance of many of the principal streets and avenues in Brooklyn, due to the removal of the great tangle of telegraph wires and poles. Some of the principal streets affected are Fulton street, Myrtle avenue, Bedford avenue, Flatbush avenue, Washington street and Broadway.

TELEPHONE AND TELEGRAPH.

LARAMIE, WYO.—A telephone line is being installed from Laramie to Cheyenne.

READING, PA.—The Consolidated Telephone Company is rapidly pushing work on its line to Boyerstown, and also on its Hamburg extension.

SUSSEX, N. J.—The Sussex Telephone Company is about to extend its line to Vernon, and has a force of men at work erecting the necessary poles.

SALT LAKE CITY, UTAH—The Rocky Mountain Bell Telephone Company is making arrangements to put in new poles along the road between Salt Lake and Ogden, Utah.

BAKER CITY, ORE.—An independent telephone line will soon be installed here by H. S. Cullum and others of Sumpter, Ore., and work will be begun at once on a line between Baker City and Sumpter.

ATLANTA, GA.—Work on the direct telephone line from Atlanta to Birmingham will be begun at once, starting at Anniston, Ala. The through line will go direct to Anniston, then to Talladega and into Birmingham.

HOLMES CITY, MINN.—The Interurban Telephone Exchange Company has filed articles with the Secretary of State increasing its capital stock from $10,000 to $100,000, and its limit of indebtedness from $1,500 to two-thirds of the amount of the capital stock subscribed.

LEWISTON, IDA.—The Nezperce Cooperative Telephone Company has completed its line from Culdesac to Mohler. This line connects with the Lewiston line to Culdesac, enabling direct communication from Nezperce. It is the company's intention to later build a line to Lewiston.

BUFFALO, N. Y.—The Ivory Telephone Company has finished its line from Frewsburg to the Pope Hollow district, beyond Ivory. The members of the company are: Clarence Taylor, H. E. Anderson, C. H. Love, Edwin Harrington and F. J. Lewis. The company connects at Frewsburg with the Bell system and thus has communication with Jamestown and nearly all the cities in the country.

KEYSER, W. VA.—A new telephone company has been organized in Keyser with a capital of $30,000, and has purchased the stock of the Piedmont Telephone Company, which has exchanges in Piedmont, Keyser and Romney, and also the Union Telephone Company, with exchanges in Keyser, Burlington and Romney. The capital is all subscribed and paid. The company has also made arrangements for the purchase of all the independent telephone lines running out of Keyser and Piedmont, and negotiations are about completed for free exchange between this company and the Cumberland & Potomac company, at Cumberland. Many improvements are contemplated.

PERSONAL MENTION.

MR. H. W. KILBOURNE has been reelected secretary and treasurer of the American District Telegraph Company.

MR. MORRIS W. MEAD, the chief of the electrical bureau of Pittsburg, spent several days last week in New York city.

MR. CYRUS O. BAKER, the platinum refiner of New York and Newark, spent several days of last week in the city of Chicago.

COLONEL R. C. CLOWRY, president of the Western Union Telegraph Company, has been elected a director of the Seventh National Bank.

MR. H. J. PETTINGELL, Boston, general manager of the Western Telephone and Telegraph Company, was a New York visitor on Monday of this week, passing through the city on his way to Texas.

MR. D. E. GOE has left the Northern Electrical Manufacturing Company, Madison, Wis. It is understood that Mr. Goe is entering the field of general advertising.

MR. J. N. JACKSON has been elected president of the Augusta, Ga., Railway and Electric Company; Mr. R. Lancaster Williams, vice-president, and Mr. A. H. Rutherford, treasurer.

MR. A. A. THRESHER, president of the Thresher Electric Works, was an attendant at the tenth general meeting of the Society of Naval Architects and Marine Engineers held in New York city last week.

MR. ARTHUR STANLEY will take charge of the New York office of Robbins & Myers, Springfield, Ohio, on December 1. Mr. Stanley's headquarters will be in the Broadway-Maiden Lane Building, where he will represent his company's well-known fan motor, power motors and specialties.

MR. R. F. HAMILTON, known to his multitude of friends as "Tody," was given a welcome-home dinner at the New York Press Club, November 20. Mr. John A. Hennessy presided, and Messrs. R. B. Roosevelt, Joseph Howard, Jr., John W. Keller, W. L. Brown and others spoke in honor of Mr. Hamilton and congratulated him on his return to this country after a five years' absence in foreign lands.

HON. GEORGE R. PECK, formerly vice-president and attorney for the Missouri & Kansas Telephone Company, now general solicitor for the Chicago, Milwaukee & St. Paul Railroad, with headquarters in Chicago, was a New York visitor last week, enjoying a reunion with his old-time western friends, Hon. Melville E. Stone, general manager of the Associated Press, and Major J. B. Pond, the Lecture Bureau manager.

MR. J. N. ABBOTT, vice-president and general manager of the Consolidated Railway, Electric Lighting and Equipment Company, of New York city, recently made a tour of the Middle West inspecting the various installations of his company's system on the railways of the country. The Pullman company is a large patron of this modern method of lighting and ventilating palace cars, and nearly all private cars that are now being built are equipped with the Consolidated company's system.

OBITUARY NOTICE.

MR. NELSON HERSH, editor of the Sunday *World*, was thrown from a trap and instantly killed at St. George, Staten Island, N. Y., early on the morning of November 20. Mr. Hersh was forty-one years of age and had a fine career as a newspaper man, having been identified with many of the prominent journals of the country. He is survived by his wife, two sons and two daughters.

LEGAL NOTE.

CORRESPONDENCE SCHOOL ALLEGED TO BE USING MAILS FOR FRAUDULENT PURPOSES—In the United States Court the Grand Jury recently made its final report and returned true bills against the officers of the Correspondence Institute of America upon the charge of using the mails for fraudulent purposes. The company has been advertising to give instructions in caricature and newspaper, magazine and commercial illustrating and advertising, and it is alleged that upon certain moneys being sent to the company for supplies, the supplies received were not anywhere near the value of the money paid for them.

ELECTRIC LIGHTING.

MIFFLINBURG, PA.—The people of this place have voted to put in a municipal electric light plant.

SAULT STE. MARIE, ONTARIO—The works of the Lake Superior Power Company were recently injured by fire to the extent of $10,000.

TAUNTON, MASS.—Work on the new municipal lighting station has been commenced, and it is expected that the building will be completed within sixty days.

JOHNSTOWN, PA.—It is estimated that the cost of the new plant for the Consumers' Light, Heat and Power Company will be about $106,000. Work will be begun as soon as possible.

SUMMITVILLE, IND.—The Summitville Electric Light and Water Company has put in operation its new water and light plant, which is to be bought by the city at a cost of about $50,000.

EPHRATA, PA.—At a recent meeting of the borough council the plant of the Conestoga Valley Electric Light Company was purchased by the village, it having decided to furnish its own light.

ALTOONA, PA.—The contract for the erection of the plant of the new Citizens' Electric Light, Heat and Power Company will be signed within a few days, and immediately thereafter the work of construction will begin.

SEATTLE, WASH.—The city council has granted permission to the Arcade Electric Company to furnish light and heat to certain portions of the city. All wires are to be underground and are to be installed at the expense of the company.

DETROIT, MICH.—The Pontiac Light and Power Company has been purchased by J. W. Martin and a Detroit capitalist whose name does not appear in the transaction. Besides furnishing light to the city, the new owners will do commercial lighting.

BROOKSVILLE, FLA.—The city council has granted to the Standard Pole and Tie Company, of this place, a franchise for a period of twenty years to establish and operate an electric lighting system in Brooksville. Work will be begun at once.

ALBANY, GA.—It is rumored here that an extensive power plant is to be built on the Kinchafoonee and Muckalee creeks, just north of Albany. The power generated would be used for manufacturing purposes in and about Albany. Surveys are now being made.

NIAGARA FALLS, N. Y.—The Ontario Power Transmission Company has made application to the town board for a franchise to do business in the village of La Salle and vicinity. It was stated that it was the intention of the company to establish a power district covering a large area of land. It agrees to furnish 5,000 horse-power within three years or forfeit its franchise.

NEW INCORPORATIONS.

CAMDEN, N. J.—Globe Automatic Telephone Company. $500,000. Incorporators: J. E. Marling, J. W. Synack and F. A. Lindymist.

KANSAS CITY, MO.—The Reed-Squire Electric Company. $40,000. Incorporators: E. M. Reed, William Squire, Lewis Crooker and H. M. Squire.

CLEVELAND, OHIO—The Western Reserve Traction Company. $10,000. Incorporators: T. C. Willard, E. J. Pinney, A. H. Gebert, C. W. Noble and M. A. Lander.

DAVENPORT, IOWA—Walther Lighting and Heating Company. $25,000. Incorporators: Edward Walther, Henry Dunker, August Zschiesche and A. W. Gifford.

MEDINA, OHIO—Medina Electric Lighting, Power and Heating Company. $50,000. Incorporators: O. P. Van Sweringer, James G. Boyd, S. Charles Stewart, A. J. Watt.

ALBANY, N. Y.—The Cooper-Hewitt Electric Company, of New York city, has been incorporated, with a capital of $2,000,000, to manufacture electric lamps in which vapor forms a portion of the conducting circuit, or in which the current is induced in a vapor. Directors: Charles B. Hill, John F. Symes, George H. Stockbridge, Charles H. O'Connor and Leavitt J. Hunt, of New York city.

ELECTRICAL SECURITIES.

The sentiment and general condition of the market show a decided improvement for the week. Speculative tendency has assumed a more healthy state and the bearish predominance of a week ago has given way to activity and upward measures. Although the past few weeks have been trying ones in the financial district, it appears as if all liquidation would be met and responsibility assumed without disaster on any hand. The continued ability of those most interested to weather these difficulties will not fail to impress outsiders with more or less confidence and the probability is that with the continued general prosperity the beginning of next year will be marked by a renewed interest in the stock market on behalf of the speculative public. Call rates for the week have ruled easy at about 5 per cent, but the monetary situation still remains a restraining factor in free speculation. The transportation companies which have made recent general advances in the wages paid to employés will no doubt advance freight charges in the near future, and in railroad circles it is freely stated that these advances will be made on all the important systems until equilibrium is restored.

ELECTRICAL SECURITIES FOR THE WEEK ENDING NOVEMBER 22.

New York:	Closing.
Brooklyn Rapid Transit	62½
Consolidated Gas	214½
General Electric	180
Kings County Electric	211
Manhattan Elevated	151
Metropolitan Street Railway	140⅛
New York & New Jersey Telephone	161
Westinghouse Manufacturing Company	208

Manhattan Elevated furnished the sensational feature of the week. This was caused by the general belief that the company is to be leased to the Interborough Rapid Transit Company with a substantial guarantee to stockholders. This is as yet without official explanation. Decided rallies were made by the other local traction issues, and while not talked of to any extent, it may be observed that Westinghouse stands 18 points higher than last week.

The annual stockholders meeting of the Metropolitan Street Railway Company will be held in New York city, December 1. A special meeting will be held the same day.

Boston:	Closing
American Telephone and Telegraph	161½
Edison Electric Illuminating	265
Massachusetts Electric preferred	96½
New England Telephone	138
Western Telephone & Telegraph preferred	98

Philadelphia:	Closing.
Electric Company of America	9½
Electric Storage Battery common	80
Electric Storage Battery preferred	80
Philadelphia Electric	9⅛
Union Traction	47
United Gas Improvement	112⅜

The Philadelphia stock exchange will enjoy a long holiday during Christmas week. Christmas will be Thursday, and the exchange will close on Wednesday and not reopen until the following Monday. The reason for this is the removal from the present location at Chestnut street and Custom House place to the renovated building at Third and Walnut streets.

Chicago:	Closing
Chicago Edison Light	107
Chicago Telephone	168
Metropolitan Elevated preferred	85
National Carbon common	30
National Carbon preferred	100
Union Traction common	18
Union Traction preferred	50

It is officially stated that Union Traction earnings have increased $32,000 for the first eighteen days of November.

Henry G. Foreman has been elected chairman of the Union Traction Company *vice* Mr. Spalding. It is reported that the company is making efforts to secure control of the Chicago City Railway Company.

ELECTRIC RAILWAYS.

FORT MADISON, IOWA—The Keokuk Electric Railway and Power Company is considering the advisability of building a trolley line between Keokuk and Fort Madison, for both freight and passenger service.

MUNCIE, IND.—Practically the entire right of way for the branch of the Union Traction line that is to connect Muncie with Portland by way of Albany, Dunkirk and Redkey has been obtained, and grading is to begin at once.

DOYLESTOWN, PA.—Work is progressing rapidly on the line of the Philadelphia, Bristol & Trenton Street Railway Company, and it is believed that the same will be in complete operation between Torresdale and Trenton before May 1.

ROCHESTER, N. Y.—The highway commissioners of the town of Batavia have granted the Union Traction Company, which proposes to build a road from Olcott, by way of Medina, a franchise on the old Lewiston road to the village line of Batavia.

LEXINGTON, KY.—At a recent meeting of the stockholders of the Blue Grass Traction Company, held in Cincinnati, the capital stock for the Paris road was increased from the nominal $10,000 to $350,000. The company expects to have cars running by February or March of next year.

BUFFALO, N. Y.—Plans have lately been matured by Buffalo and New York capitalists for the construction of a well equipped, high-speed trolley line from Lockport to Rochester. Work has already been begun on one section of the road, and within a year the construction of the whole line will be far advanced.

SCRANTON, PA.—The Lackawanna company is making preparations to erect a large power-house at the Hampton colliery in the Keyser Valley. This will eventually supply power for the company's sixteen collieries in this region. The plant will cost about $150,000, and it is estimated that the work will not be completed for about nine months.

SYRACUSE, N. Y.—The directors of the Syracuse Rapid Transit Railway Company recently voted to build a trolley road from Syracuse to Oswego, to cost about $1,000,000. The present directors of the road will furnish most of the capital. It is the plan to run from this city to Oswego in less than an hour. Work will begin as soon as the franchises are perfected.

KNOXVILLE, TENN.—It is reported that Philadelphia capitalists are interested in a scheme to connect the towns of Bristol and Rogersville by an electric line, which is to pass through Kingsport. At the latter place is to be built the power-house, and the Holston River is to be harnessed to generate the electricity. Rights of way have been secured for almost the entire distance.

CHICAGO, ILL.—The Chicago, Elgin & Waukegan Railway Company, recently incorporated, has begun negotiations for an entrance to Waukegan from the west over a private right of way. The company plans to run from there northwesterly to Fox Lake, thence through Wauconda and Barrington to Elgin, and eventually into Indiana. The route has been laid out from Elgin to Waukegan, and much right of way secured.

RICHMOND, VA.—The Virginia Passenger and Power Company is rapidly pushing the work on its great power plant at the canal locks in Dinwiddie County, as well as the work of clearing and grading preparatory to widening and deepening the canal from the locks to the river, so as to secure the proper water power. It is expected that when completed the plant will be capable of furnishing almost unlimited power.

LEXINGTON, KY.—C. H. Berryman, Stanley Milward and Rudolph R. Harting, all of Lexington, have incorporated the North Middletown, Winchester & Lexington Right of Way and Franchise Company, with a capital stock of $5,000. The purpose of the corporation is to acquire and hold, transfer or assign rights of way and franchises for the construction of a line to commence at a point near Lexington and extend thence in a general easterly direction through Fayette and Clark counties, to a point at or near the limits of the city of Winchester, a distance of about twenty miles. There will also be a line running from Lexington through the counties of Fayette, Clark and Bourbon to the city of North Middletown and to Sharpsburg, a distance of about thirty-five miles.

INDUSTRIAL ITEMS.

THE GEORGE C. TOWLE MANUFACTURING COMPANY, Lancaster, Pa., is keeping up with its large amount of business at the present time, and is making a specialty of a rotary converter for running X-ray and static machines.

THE METROPOLITAN SWITCHBOARD COMPANY, of New York city, is manufacturing telephone switchboard and panel boards. Mr. T. J. Murphy, president of the company, states that recent news to the effect that this company was a part of the American Union Electric Company is erroneous.

THE SMITH STORAGE BATTERY COMPANY, Binghamton, N. Y., is the manufacturer of the Smith patent "tray plate" type storage battery. This battery is of novel construction, and the manufacturer claims a great many excellent features, owing to the radical departure in the construction of this battery.

THE ELECTRIC APPLIANCE COMPANY, Chicago, Ill., is advertising Packard incandescent lamps as "quality lamps." The company claims that this extra quality is attained in the Packard lamp, and that this fact is being discovered by users generally. A greatly increasing output is pointed to as evidence of this fact.

THE UNION SWITCH AND SIGNAL COMPANY, Swissvale, Pa., is publishing a series of bulletins descriptive of its interlocking and signaling devices. These are published in sections and include every description of signaling device that is possible in this field of construction. One of peculiar interest to electrical engineers is Bulletin No. 6, descriptive of the Union electric semaphore signal.

THE SUN ELECTRIC MANUFACTURING COMPANY, West Chester, Pa., will be sold by its assignees, W. L. Doyle and Henry C. Baldwin, on Wednesday, December 10, at the premises. The sale includes a complete plant for the manufacture of telephones and telephone switchboards, a lot of raw material and a full office equipment.

THE NATIONAL BATTERY COMPANY, Buffalo, N. Y., will be pleased to send to any one interested upon request some recent literature which it has prepared relative to "National Storage Batteries as Applied to Railway Central Stations and Isolated Plants," and on "Some Facts About the Sperry Battery as Applied to Electric Vehicles." The reading is of great interest and value to any one contemplating the study or use of electric batteries.

ROTH BROTHERS & COMPANY, Chicago, Ill., manufacturer and exporter of dynamos and electric motors, has been favored with a remarkable increase of business during the past year. The capital stock of the company has just been increased from $60,000 to $160,000, and it is intended in the near future to remove the factory into larger quarters in order to double the facilities and output. Illustrated catalogues, completely describing the machines manufactured by the company, will be sent upon request.

THE KNAPP ELECTRIC AND NOVELTY COMPANY, New York city, is the manufacturer of a number of electrical toys which possess more than ordinary utility and attractiveness. One of the most useful of these designs is an electric railroad. The motor for the car is self-starting, and so made that it drives the apparatus on less than two watts. It is geared direct to the truck the same as the large cars and works with absolute precision. The track is nine feet circumference, and an ordinary cell will drive car for about three hours without recharging.

THE ELECTRIC STORAGE BATTERY COMPANY, Philadelphia, Pa., will install a battery of chloride accumulators, consisting of 264 elements, at Windermere, a point about five miles from the power-house of the Cleveland Electric Railway Company. This battery is capable of discharging at the rate of 1,200 amperes, and besides regulating the fluctuations of the load it will maintain the voltage during the hours of peak load, and is also intended to assist in carrying the load on the Euclid Beach line, which has very heavy traffic during the summer months.

EIMER & AMEND, New York city, the well-known supply house for medicinal and physical specialties, is exhibiting a considerable range of electrical chemical furnaces. These are specially constructed for work in qualitative, quantitative and metallurgical laboratories. They are strong and compact and are built in sections so that all parts can be readily replaced in case of accident. A feature of great importance also is that they may be operated with the regular electric light, 110-volt current. A number of other electrical specialties, in the form of pyrometers and sectional combustion furnaces, are also found at this house.

THE ELBLIGHT COMPANY OF AMERICA has been incorporated under the laws of the state of New York by Mr. Russell Spaulding. This company has purchased the good will, patents and assets of the National Electric Improvement Company. Since the formation of the Elblight Company of America, subcompanies have been formed, *viz.*, the Elblight Company of Pittsburg, the Cincinnati Elblight Company, the Elblight Company of Chicago, and the Elblight Company of California. Besides these, there are in process of formation the Elblight Company of Boston, the Elblight Company of Philadelphia, the St. Louis Elblight Company, the Elblight Company of Denver, the Elblight Company of Oregon, and the Elblight Company of Canada. The remaining territory in the United States has been allotted to about fifty agents, whose contracts are subject to the formation of subcompanies in their districts. In addition to the decorative value of the Elblight system, it has been developed on such lines as will adapt it for all conditions where a weather-proof, water-proof, gas-proof and acid-proof cable is required.

E. H. ABADIE & COMPANY—After several months of rest and recreation, following the closing out of the sales organization of the Bullock Electric Manufacturing Company and the Wagner Electric Manufacturing Company, Mr. Eugene H. Abadie, the late manager of sales of these companies who has been identified with this work for the past eleven years, has decided to make his permanent headquarters in the city of St. Louis. This city possesses an advantageous location and there are excellent prospects for industrial development in the adjacent territory, particularly in the South and Southwest. Mr. Abadie has formed a partnership with Mr. C. L. Michod, who has had practical engineering experience in the United States and France, Switzerland and Germany. These gentlemen, under the name of E. H. Abadie & Company, with offices in the Bank of Commerce Building, St. Louis, propose doing a general engineering and contracting business and are acting in the capacity of manufacturers' agents for the sale of apparatus for complete installations, among which are Habirshaw wire and cable, Wood systems and the new Elblight system. The ELECTRICAL REVIEW extends best wishes for full success to the new firm. Its members possess ambition and ability combined with practical engineering and business experience in the electrical field.

THE ALLIS-CHALMERS COMPANY, Chicago, Ill., reports the following partial list of engine sales for October, 1902: Indiana Rolling Mill Company, Newcastle, Ind., one 26 x 48-inch, 1890, Reynolds-Corliss engine, one 28 x 48-inch, 1890, Reynolds-Corliss engine; Theresa Gold Mining Company, Col., 16 and 16 x 30-inch, single drum hoist; Scott & Van Arsdale Lumber Company, McCloud, Cal., one 26 x 48-inch, 1890, Reynolds-Corliss engine; Downie-Wright Manufacturing Company, York, Neb., one 12 x 36-inch, girder frame, Reynolds-Corliss engine; Kirby Lumber Company, Houston, Tex., one 22 x 48-inch, 1890, Reynolds-Corliss engine; Colean Implement Company, Peoria, Ill., one 18 x 42-inch, girder frame, Reynolds-Corliss engine; Wyckoff, Seamans & Benedict, Ilion, N. Y., one 14 and 28 x 30-inch, 1890 frame, cross-compound, direct-coupled, Reynolds-Corliss engine; Compania Minera De Penoles, Mexico, one straight line, Riedler express air compressor, with steam cylinder, 14 x 18-inch, air cylinder, 10½ and 18 x 18-inch; Chicago Edison Company, Chicago, Ill., 32 and 64 x 60-inch, vertical, cross-compound, direct-coupled, Reynolds-Corliss engine; National Tube Company, Pittsburg, Pa., six 22 and 42 x 42-inch, vertical, cross-compound, direct-coupled, Reynolds-Corliss engines, 44 and 84 x 60-inch, vertical blowing engine; Scott & Van Arsdale Lumber Company, St. Cloud, Minn., 18 x 42-inch, 1890 frame, Reynolds-Corliss engine, 22 x 42-inch, 1890 frame, Reynolds-Corliss engine; Minot Milling Company, Minot, N. Dak., 12 x 36-inch, girder frame, Reynolds-Corliss engine; Columbus Milling Company, Columbus, Ohio, 14 x 36-inch, girder frame, Reynolds-Corliss engine; National Biscuit Company, Chicago, Ill., 20 x 36-inch, 1890, direct-coupled, Reynolds-Corliss engine; Carnegie Steel Company, Pittsburg, Pa., 48 and 78 x 60-inch, combined horizontal and vertical, Reynolds-Corliss engine; D. E. Converse Manufacturing Company, Glendale, S. C., 14 x 36-inch, 1890, Reynolds-Corliss engine; city of Milwaukee, one 8,000,000-gallon, vertical, triple-expansion pumping engine; Pennsylvania Railroad Company, Pennsylvania, two Sederholm boilers, 384 horse-power each.